Operating and Maintenance Handbook

MARCONI INSTRUMENTS LIMITED, ENGLAND

TELEGRAPH TEST GENERATOR

TYPE TF 1167

MP MASTER

MA23625

MARCONI INSTRUMENTS

105/16749

OM 1167
1** - 4/58

TTO OFFICE 0337

OPERATING AND MAINTENANCE HANDBOOK

for

TELEGRAPH TEST GENERATOR

TYPE TF 1167

Admiralty Designations:

Frequency Shift Simulator AP 103530

Stabilised Power Unit AP 103531

AMENDMENTS, if any, are included at the back of this handbook.

Marconi Instruments Limited, St. Albans, Hertfordshire, England. Telephone : St. Albans 59292

CONTENTS

1. DESCRIPTION — Pages 6 - 14

GENERAL ..... Sect. 1.1.
DESIGN DETAILS ..... Sect. 1.2.
R.F. Circuits ..... Sect. 1.2.1.
Modulation Circuits ..... Sect. 1.2.2.
On-Off Keying ..... Sect. 1.2.2.1.
Frequency Shift Keying ..... Sect. 1.2.2.2.
Diplex Keying ..... Sect. 1.2.2.3.
Amplitude Modulation ..... Sect. 1.2.2.4.
Power Supply Unit ..... Sect. 1.2.2.5.

2. OPERATION — Pages 15 - 29

INSTALLATION ..... Sect. 2.1.
SWITCHING ON AND WARMING UP ..... Sect. 2.2.
KEYING INPUT ARRANGEMENTS ..... Sect. 2.3.
R.F. OUTPUT ARRANGEMENTS ..... Sect. 2.4.
Output Connector ..... Sect. 2.4.1.
Output Controls ..... Sect. 2.4.2.
Outputs from 2 μV to 200 mV at 75 ohms ..... Sect. 2.4.3.
Outputs in Terms of the Voltage Developed Across an External Load ..... Sect. 2.4.4.
Increasing the Output Impedance ..... Sect. 2.4.5.
Reducing the Output Impedance ..... Sect. 2.4.6.
SETTING UP PROCEDURE ..... Sect. 2.5.
ON-OFF Keying ..... Sect. 2.5.1.
Frequency Shift Keying ..... Sect. 2.5.2.
Diplex (Twinplex) Keying ..... Sect. 2.5.3.
External Sinewave Amplitude Modulation ..... Sect. 2.5.4.

3. OPERATIONAL SUMMARY — Pages 30 - 32

4. MAINTENANCE — Pages 33 - 57

GENERAL ..... Sect. 4.1.
FUSE REPLACEMENT ..... Sect. 4.2.
MAINS INPUT ARRANGEMENTS ..... Sect. 4.3.

CONTENTS (continued)

REMOVAL OF COVERS ..... Sect. 4.4.
ACCESS TO SUB-ASSEMBLIES ..... Sect. 4.5.
R.F. Section..... Sect. 4.5.1.
Oscillator Coil Assembly..... Sect. 4.5.2.
Fine Attenuator..... Sect. 4.5.3.
Coarse Attenuator ..... Sect. 4.5.4.
WORKING VOLTAGES ..... Sect. 4.6.
REPLACEMENT OF VALVES AND CRYSTALS .... Sect. 4.7.
PRESET AND SPECIALLY SELECTED
COMPONENTS..... Sect. 4.8.
SCHEDULE OF TESTS ..... Sect. 4.9.
Apparatus Required ..... Sect. 4.9.1.
Measurement of Mains Variation Effects..... Sect. 4.9.2.
Measurement of Hum Level on H.T. ..... Sect. 4.9.3.
Oscillator Tuning..... Sect. 4.9.4.
Output Amplifier Tuning..... Sect. 4.9.5.
Adjustment of Acceptor Circuit ..... Sect. 4.9.6.
Setting Up the Output Level..... Sect. 4.9.7.
Adjustment of F.S.K. 'Mark' Frequency..... Sect. 4.9.8.
Adjustment of Maximum 'Space' Shift ..... Sect. 4.9.9.
Adjustment of Frequency Shift Ratio
at 6.2 and 9.3 Mc/s ..... Sect. 4.9.10.
Calibration of SHIFT Dial ..... Sect. 4.9.11.
Setting Up the Diode Gating Circuit ..... Sect. 4.9.12.
Adjustment of External Amplitude
Modulation Depth..... Sect. 4.9.13.
Measurement of Mark/Space Suppression..... Sect. 4.9.14.
Measurement of Bias Distortion..... Sect. 4.9.15.
Measurement of Spurious Amplitude
Modulation on F.S.K. ..... Sect. 4.9.16.
Measurement of Frequency Stability ..... Sect. 4.9.17.

APPENDICES

VALVE REPLACEMENT DATA..... VRD 1167
COMPONENT LAYOUT ILLUSTRATIONS..... MP 1167 -1 to -6
SPARES ORDERING SCHEDULE WITH
CIRCUIT REFERENCES..... SOS/1167
BLOCK SCHEMATIC DIAGRAM..... TLC 27265

CONTENTS (continued)

TELEGRAPH TEST GENERATOR CIRCUIT DIAGRAM ..... TLD 27788 (Sheet 1)

STABILIZED POWER UNIT CIRCUIT DIAGRAM ..... TLC 27802 (Sheet 1)

DECIBEL CONVERSION TABLE ..... OM G-SUPP dB

DRAWINGS INCLUDED IN TEXT

GATING CIRCUIT AND WAVEFORMS ..... TLC 27773 (follows page 13)

SCHEDULE OF PARTS SUPPLIED

The complete equipment comprises the following items :-

1. One Telegraph Test Generator Type TF 1167, including a separate Stabilized Power Unit Type TM 5195, and with valves etc., as under :-

Valves :	Five:	Type 12AT7 (CV455), Double Triodes
	Four:	Type 6AL5 (CV140), Double Diodes
	Two:	Type 6AM6 (CV138), Pentodes
	One:	Type 6CH6 (CV2127), Pentode
	*Two:	Type STV 280/80, Voltage Stabilizers
Crystals :	One:	Type CG1-E (CV425), Germanium Diode
	One:	Type WZ 4152, 3.1 Mc/s Oscillator Crystal
	Two:	Type ZB18, Zener Diodes
Lamp :	One:	6.3 volt, 0.15 amp, M.B.C. Pilot Lamp
Fuses :	One:	15 amp, Glass Cartridge
	One:	2 amp, Glass Cartridge
	Two:	250 mA, Glass Cartridge

2. Three Telephone Plugs, P.O. Type 316.

3. One Coaxial Socket, free male, Pye Type 732557 (Z540155).

4. One Mains Lead, Type 2560 AR.

5. One Interconnecting Lead, with 8-way Jones plug and socket terminations.

6. One Interconnecting Lead, with 6-way Jones plug and socket terminations.

7. One Operating and Maintenance Handbook OM 1167.

* The two voltage stabilizer tubes are contained in a separate protective packing.

1. DESCRIPTION

1.1. GENERAL

The TF 1167 Telegraph Test Generator delivers keyed r.f. signals at crystal-stabilized carrier frequencies of 3.1, 6.2, and 9.3 Mc/s. On-off, frequency-shift, or frequency-shift diplex (twinplex) keying can be selected, or the carrier can be externally sinewave amplitude modulated.

The instrument is primarily designed for the overall testing of h.f. telegraph receivers under a wide range of keying conditions: it can, for example, be used with a telegraph distortion measuring set or a short-element fault counter to assess the extent to which a receiver distorts teleprinter characters or to determine the minimum input required to meet a specified error rate; it enables a functional check to be made of the recording stages and a.f.c. circuits; and, by utilizing the sinewave a.m. output with 100% modulation, it facilitates accurate setting of the receiver signal bias or slicing control. For h.f. transmitters using the conventional 3.1-Mc/s input frequency, the Generator provides a convenient telegraph test drive in such applications as checking the transmitter radiated bandwidth.

Either an internal or external keying signal can be employed. The internal signal is in the form of a squarewave at the mains supply frequency and having a keying speed of 100 bauds in the case of 50-c/s supplies. External electronic keying can be applied, for example, from any electronic test sender with a 30-0-30 volt output; alternatively, external mechanical keying can be employed by making direct connection to the contacts of a hand key, relay, 5-unit sending head, or Wheatstone morse transmitter. The maximum external keying speed is 500 bauds.

In the case of f.s.k. diplex working, both channels can be keyed externally, or one internally and one externally; the two keying signals can be combined according to either the Code 1 or Code 2 system.

When using single-channel f.s.k., a selective fading effect can be simulated by means of a panel control which reduces the level of the lower frequency signal. Total frequency shift is directly indicated and continuously variable up to 1,300 c/s for both simple and diplex f.s.k.

1.1. (continued)

The Test Generator output is delivered via coarse and fine step attenuators, which, in conjunction with a fine interpolating control, provide a continuously variable output calibrated in terms of source e.m.f. from 2 μV to 200 mV at a source impedance of 75 ohms.

A separate stabilized power supply unit allows operation from 40- to 100-c/s supplies within the ranges 100 to 150 volts, and 200 to 250 volts.

1.2. DESIGN DETAILS

The following detailed description is intended to be read in conjunction with the Block Schematic Diagram, Drawing No. TLC 27265; the Test Generator Circuit Diagram, Drawing No. TLD 27788; and the Power Unit Circuit Diagram, Drawing No. TLC 27802. These drawings are located at the end of the handbook.

1.2.1. R.F. Circuits

The 3.1-Mc/s oscillator, V2b, is a crystal-stabilized Hartley type; the series-resonant crystal, XL1, is connected in parallel with the tuned circuit, which comprises L5 with preset capacitor C20 for synchronizing the frequency of the L-C oscillator with that of the crystal. The 3.1-Mc/s output is taken from a tapping near the earthy end of L5 and fed to the buffer amplifiers, V3. The amplifier is operated in Class B, thus producing an output rich in harmonics; this signal is fed to the grid of the final power amplifier, V4, whose anode load is tuned by means of preset capacitors to the fundamental or 2nd or 3rd harmonic depending on the position of the FREQUENCY switch S1; the three output frequencies produced in this way are 3.1 Mc/s, 6.2 Mc/s, and 9.3 Mc/s. An acceptor circuit is switched into the grid of the power amplifier on the two higher ranges to suppress the 3.1-Mc/s component at the 6.2-Mc/s position, and the 6.2-Mc/s component at the 9.3-Mc/s position of the FREQUENCY switch.

The gain of the power amplifier is controlled by means of the SET CARRIER control, RV1, in the h.t. supply to the screen grid. From the anode of the amplifier the output is transformer coupled into the two output attenuators. These are resistive 75-ohm ladder networks

1.2.1. (continued)

connected in cascade; the first has a range of 80 dB variable in 20-dB steps, and the second a range of 20 dB variable in 1-dB steps. The output from the second attenuator is fed to the output plug, PL3, on the front panel.

A crystal rectifier and voltmeter circuit is connected across the input to the first attenuator to monitor the reference level. When the SET CARRIER control is adjusted to bring the pointer of the CARRIER LEVEL meter to the zero mark, the attenuator calibration is correct at all settings, providing a calibrated 75-ohm output with a source e.m.f. variable from 2 μV to 200 mV. Two further marks are provided on the meter showing plus and minus 1 dB respectively; these, in conjunction with the SET CARRIER control, allow interpolation between the steps of the second or fine attenuator.

1.2.2. Modulation Networks

1.2.2.1. On-Off Keying (A1)

This type of modulation is produced by applying a square-wave signal to the suppressor grid of the buffer amplifier, V3. With no keying signal applied, this valve is normally cut-off on the suppressor grid by a standing bias derived from the -140 volt line via R51, S5a and J3. The polarity of the square wave is such as to overcome the bias on the suppressor grid during the 'space' periods.

With the Service switch, S3, set to ELEC. INT. CH. A, internal keying is produced at the mains frequency by applying the filament supply voltage via transformer T2 to section 'b' of the amplifier/limiter stage, V12; from the anode of V12a, the squared signal is fed via the potential divider, R53/R54, and the selector switch S2b, to the grid of cathode follower V10a. The 'space' elements, as defined in Section 2.3., allow V10a to conduct, reducing the bias applied to the suppressor grid of the buffer amplifier.

With S3 set to ELECT. EXT., an external keying voltage can be applied to V12b via telephone jack 'A', J2. A negative input applied to the jack corresponds to a 'mark' signal. Jack 'B' is used only for two-channel diplex working.

1.2.2.1 (continued)

With S3 set to MECH., external mechanical keying can be employed by making direct connection from the front-panel terminals designated CHANNEL A to the contacts of a relay or other keying device. No external voltage is applied to the terminals.

The individual terminal designations M, T and S refer to the Mark, Tongue and Space contacts of a conventional double-current keying relay. The M terminal is at a potential of -105 volts, derived from potential divider R59/R63, between the -140 and -70 volts bias lines; the S terminal potential of -35 volts is derived from the potential divider formed by R56 and two Zener diodes, MR1 and MR2. With mechanical keying applied, the T terminal potential alternates between that of the M and S terminals and describes a squared keying signal; this is again fed through the amplifying and squaring circuits and applied to the suppressor grid of the buffer amplifier.

1.2.2.2 Frequency Shift Keying (F1)

For f.s.k. modulation, a squared signal is applied to the grid of the reactance valve, V1, connected across the oscillatory circuit of V2. The polarity of the square wave is such as to increase the oscillator frequency during 'space' periods; the frequency remains at 3.1 Mc/s (or 6.2 or 9.3 Mc/s) during 'mark' periods. This is, in effect, a single-current system. As with on-off keying, the square-wave signal is derived from either the internal electrical or an external mechanical or electrical source, depending on the position of S3, external mechanical or electrical keying being applied by way of the appropriate front-panel inlets.

Internal keying is produced at the mains frequency by applying the filament supply voltage via transformer T2 to section 'b' of the amplifier/limiter stage, V12; from the anode of V12a, the squared signal is fed via R52 to V11 and to the grid of the cathode follower V10b. V11 limits the positive and negative excursions of the square wave to about +6 volts and zero respectively. The output from V10b is taken from the potential divider R50/R118 and fed via S2B and RV7, the SHIFT control, to the grid of the reactance valve, RV7, by varying the square-wave amplitude, allows the frequency shift to be continuously adjusted from 0 to 1300 c/s, and carries a dial calibrated at 50-c/s intervals. The potential divider, R4/R5/R6, associated with the FREQUENCY switch, S1b, maintains the

1.2.2.2. (continued)

validity of the shift dial calibration at each of the three carrier output frequencies by dividing the amplitude of the keying signal applied to the reactance valve by a factor of 2 when switched to 6.2 Mc/s, and 3 when switched to 9.3 Mc/s.

For external electrical or mechanical keying, the input to V12b is derived from jack 'A' or the CHANNEL A terminals in the same way as that described for on-off keying, and again produces a continuously variable amplitude square-wave which is applied to the reactance valve.

A selective fading effect, which reduces the amplitude of the unshifted or lower-frequency output signal, can be obtained by applying the square-wave keying signal to the suppressor grid of the buffer amplifier, V3, as well as to the reactance valve. This is done by closing switch S5; switch section 'b' completes the circuit between the grid of V10a and the junction R53/R54 in V12a output (as used in the on-off keying arrangement), while switch section 'a' connects the output of V10a, via RV8, to the suppressor grid of V3.

1.2.2.3. Diplex (Twinplex) Keying

The Frequency Shift Diplex (or Twinplex) system allows the simultaneous emission of two independently keyed signals.

In the Telegraph Test Generator this is done by combining two square-wave keying signals in a system of diode gates, V7 to V9, the output from which is applied to the reactance valve. The two keying signals may each be derived externally, or one externally and one internally.

Whereas in simple f.s.k., two radiated frequencies are employed - one for 'mark' and the other for 'space', the diplex system employs four radiated frequencies - one for each combination of 'mark' or 'space' on one keying signal with 'mark' or 'space' on the other signal. The following table shows how the four radiated frequencies are allocated to each combination of 'mark' and 'space' on the two keying lines, designated Channel A and Channel B. The frequencies are related to mark/space combinations according to either of two conventions, called Code 1 and Code 2.

1.2.2.3. (continued)

CODE 1			CODE 2		
FREQUENCY	CHANNEL A	CHANNEL B	FREQUENCY	CHANNEL A	CHANNEL B
f_1	SPACE	MARK	f_1	SPACE	SPACE
f_2	SPACE	SPACE	f_2	SPACE	MARK
f_3	MARK	SPACE	f_3	MARK	SPACE
f_4	MARK	MARK	f_4	MARK	MARK

f_1, f_2, f_3, and f_4 are separated by equal increments in frequency. In the Telegraph Test Generator, f_1 is at the unshifted frequency of 3.1 Mc/s (or 6.2 or 9.3 Mc/s) while f_2, f_3, and f_4 occur at maximum shifts of 400, 800, and 1200 c/s respectively.

To illustrate the two combining systems, fig. 1, overleaf, shows a signal 'V' in Morse code on Channel A, a signal '0' in Morse code on Channel B, and the combined output signal using either Code 1 or Code 2.

1.2.2.3. (continued)

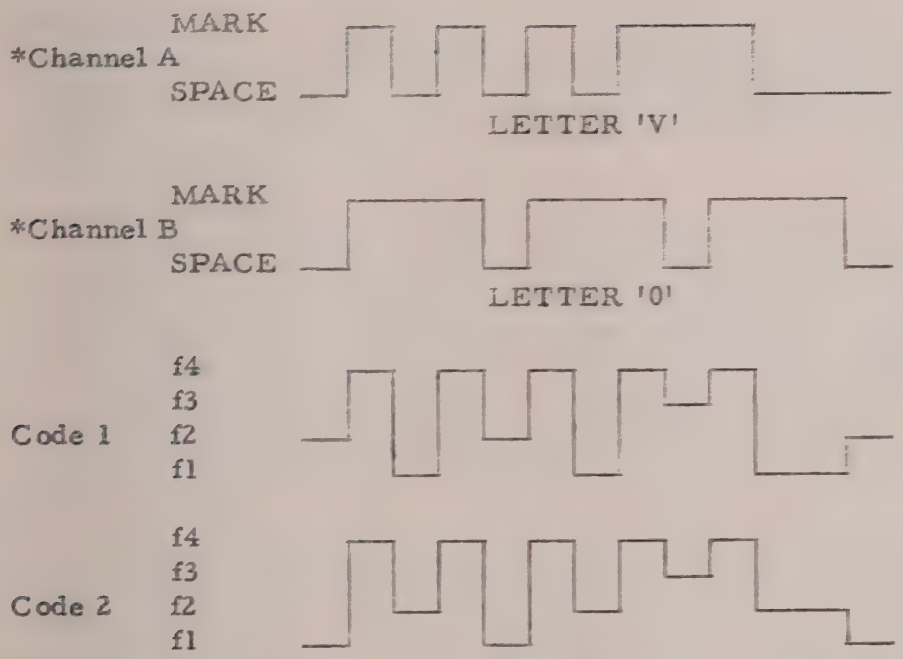


FIG. 1.

* Note: Conventional polarity has been used in this representation of the letters 'V' and '0'. The corresponding keying waveforms applied to the Telegraph Test Generator are inverted with respect to those in the diagram.

Channel A and Channel B keying signals are applied to the left- and right-hand halves respectively of the double triode limiter, V5. The Channel A signal is derived, via limiter V12, from either the internal mains-frequency square wave, or the Channel A external keying jack or terminals in the same way as that already described for on-off keying The Channel B signal is taken to V5b directly from the 'B' jack or 'B' terminals; since squaring takes place in V5b, the Channel B signal, like that of Channel A, can be of either sine- or square-wave form.

For Code 2 operation, the two square-wave signals from V5 anodes are applied direct to the diode gating circuit, V7/V8/V9; for Code 1 operation, switch S4 is moved to its alternative position, and the square-wave signal derived from the Channel B input is inverted by V6a.

1.2.2.3. (continued)

The combined waveform from the gating circuit, which has a form similar to that illustrated in Fig. 1, page 12, is applied to the grid of cathode follower V6b, output being taken from the potential divider R38/39 via switch S2b and RV7, the SHIFT control, to the grid of the reactance valve.

The operation of the diode gating circuit may be more readily understood by considering the particular case of Channel A and B signals being square waves of the same periodic time but with a phase difference of $\pi/2$. The circuit waveforms for this condition are illustrated on Drawing No. TLC 27773 which follows this page. Six diodes - three double diodes in practice - are used, in which the electrodes are held at the potentials required to produce the various voltage levels of the stepped waveform. The circuit operates as follows:-

The Channel A square wave, Fig. 2 (a), is applied via R40 to V7 and to the output. The cathode potential of V7b is held at E_3, hence the peak positive value of the signal will be limited to E_3; similarly, as V7a anode is at E_0, the peak negative value of the signal will be E_0, - Fig. 2 (c).

In Code 2 operation, Channel B square wave, Fig. 2 (b) is applied to V8 cathodes via R41, and V9 anodes via R42. The anode of V8b is held at E_2, hence limiting the negative value of the cathode input signal to E_2 - Fig. 2 (d); no limit is imposed on the positive value. Similarly, the cathode of V9b is held at E_1, limiting the positive value of the anode input signal to E_1 - Fig. 2 (f).

During the period when the cathodes of V8 are negative with respect to the output line, (i.e. V8 cathodes at E_2, V7b anode at E_3), section 'a' of V8 will conduct and the voltage on the output line will drop to E_2, - Fig. 2 (e).

During the period when the anodes of V9 are positive with respect to the output line, (i.e. V9 cathodes at E_1, V7b anode at E_0), V9a will conduct and the voltage on the output line will rise to E_1, - Fig. 2 (g).

In Code 1 operation, a phase-inverted Channel B input signal is applied to V9 anodes, - Fig. 2 (h). In this condition the final output signal waveform will be as shown in Fig. 2 (j).

GATING CIRCUIT

AND

WAVEFORMS

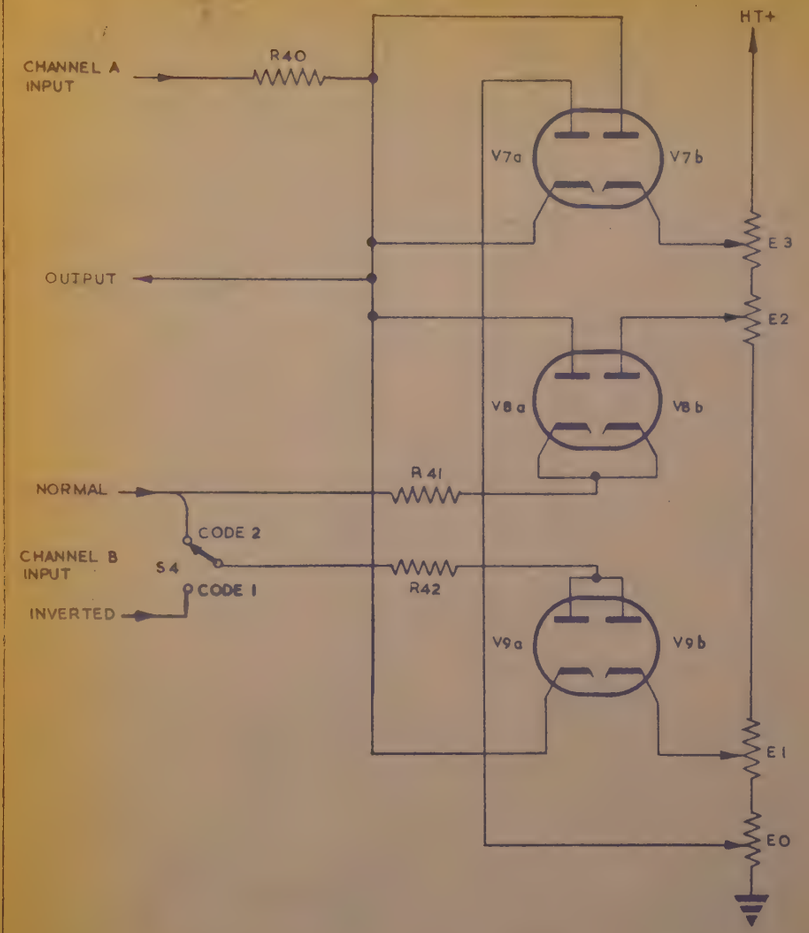


FIGURE 1

SIMPLIFIED CIRCUIT

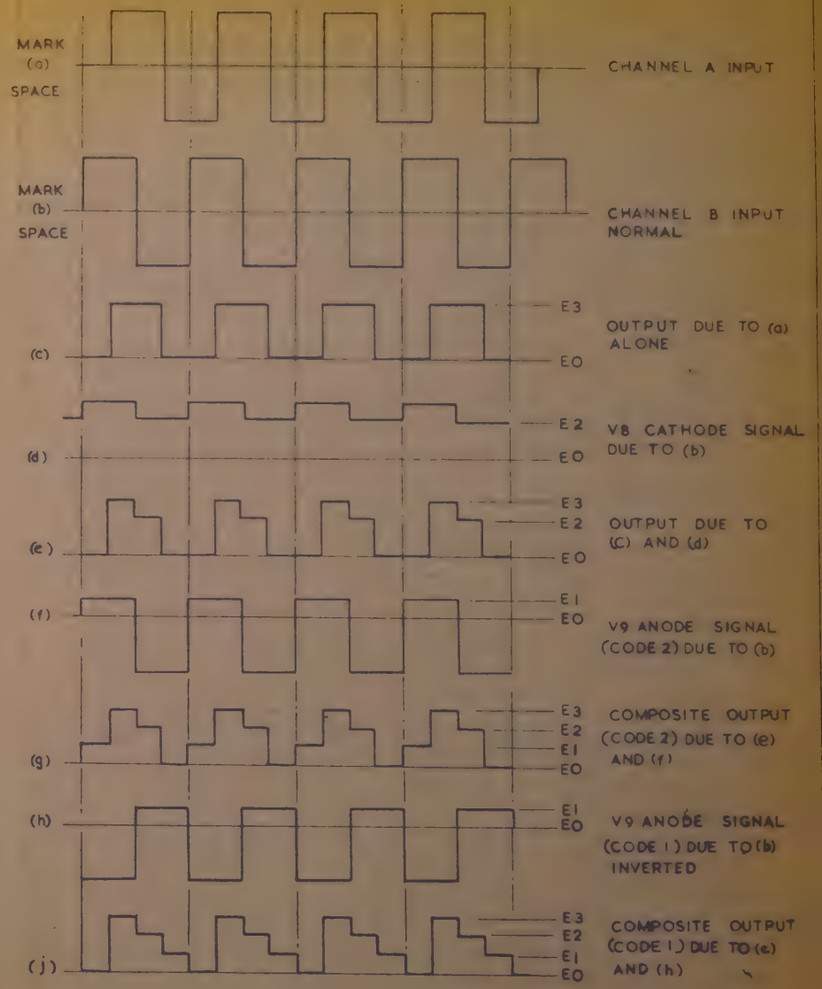


FIGURE 2

DIPLEX KEYING WAVEFORMS

GATING CIRCUIT AND WAVEFORMS

MARCONI INSTRUMENTS LIMITED							
DRN	G.R.G.	DATE	18-1-58	CHKD	G.R.G.	ISSUE	1
STOCK LIST	TF 1167		DRG NO	TLC 27773			

1.2.2.4. Amplitude Modulation

The r.f. signal from the oscillator can be externally sine-wave amplitude modulated by applying the modulating signal to the EXT. MOD. front-panel telephone jack, J3.

Inserting the plug in the EXT. MOD. jack automatically removes the suppressor grid bias on V3, and replaces it with a lower value of bias derived from the -140 volt line via potential divider R47/R48. In this way, the buffer amplifier is allowed to conduct and the Test Generator delivers an uninterrupted c.w. output. The external modulating signal is superimposed on this reduced suppressor bias, a signal of about 10 volts r.m.s. being sufficient for 100% modulation.

The carrier level for amplitude modulation is lower than that used for on-off, f.s.k., or diplex keying, due to the different biasing conditions on the buffer amplifier. The calibration of the coarse and fine attenuators is therefore no longer valid.

1.2.2.5. Power Supply Unit

The separate Power Unit, TM 5195, provides the necessary h.t. and filament heating supplies for the Telegraph Test Generator via two interconnecting cable-forms. The a.c. mains supply is fed to the mains transformer, T1, via a double-pole switch and a fuse. The two h.t. windings of the mains transformer feed full-wave metal rectifiers with choke-capacitance smoothing circuits, which provide positive and negative h.t. supplies. Multi-electrode voltage stabilizers are used to obtain the various positive and negative h.t. voltages. Both the l.t. and the main positive and negative h.t. circuits are protected by fuses.

The mains transformer primary connections can be adjusted to allow operation from 40- to 100-c/s supplies within the ranges 100 to 150 volts and 200 to 250 volts.

2. OPERATION

2.1. INSTALLATION

Unless otherwise specified, the Telegraph Test Generator is dispatched with all valves and crystals in position, with the exception of the Power Unit valves V1 and V2. These two valves - voltage stabilizers type STV 280/80 - are normally removed and packed separately, as they are more prone to damage during transit. On receipt of the instrument, the user should remove the stabilizer valves from their protective packing and insert them in their correct holders.

IMPORTANT: The two stabilizer valves are not interchangeable; each is marked with its circuit reference number on the moulded base and must only be inserted in the corresponding holder.

The mains input circuit is normally adjusted ready for immediate use with a 240-volt a.c. supply, unless it has been otherwise specified at the time of ordering. Adjustment can be made for operation from any other 40- to 100-c/s supply in the ranges 100 to 150 volts and 200 to 250 volts; to check or alter the setting of the mains transformer tappings, refer to section 4.3 - MAINS INPUT ARRANGEMENTS.

Connect the two cableforms carrying the heater and h.t. supplies between the sockets at the rear of the Power Unit and the plugs at the rear of the Test Generator.

2.2. SWITCHING ON AND WARMING UP

Before switching on, be quite sure that the instrument is correctly adjusted to suit the particular mains supply to which it is to be connected. Then proceed as follows:-

(1) Connect the mains lead supplied with the instrument between the mains input plug on the rear of the Power Unit and the mains supply socket.

(2) Switch on supplies by means of the MAINS switch on the Power Unit. The red pilot lamp should then glow.

2.2 (continued)

(3) Before proceeding further, allow a short time - say five minutes - to elapse for the internal circuits to warm up. For the highest frequency stability, this time should be increased to about 30 minutes.

(4) If the highest shift accuracy is required, standardize the SHIFT dial using the SET. FREQ. SHIFT control as described in Section 4.9.9. When this has been done an accuracy of better than ±25 c/s can be expected at all settings of the dial.

2.3 KEYING INPUT ARRANGEMENTS

External keying for on-off, f.s.k. and diplex operation can be applied electronically or mechanically at speeds up to 500 bauds (625 words/min Morse Code).

Mark and Space Conventions

In the Telegraph Test Generator, 'mark' and 'space' are defined as follows :-

On-off keying :	'Mark' - output suppressed 'Space' - output produced
Frequency Shift keying :	'Mark' - frequency unshifted 'Space' - frequency shifted (upwards)

Electronic Keying

Electronic keying signals, of square or sinusoidal wave shape, are injected into the EXT. ELECT. jack 'A' (or 'A' and 'B' for diplex working) using a three-pole telephone plug, three of which are provided with the instrument. Either single- or double-current keying may be employed.

A negative voltage in the range 0 to -100 volts, applied to the inner pole of the plug, or the absence of keying signal, constitutes a 'mark' signal.

A positive voltage, between 3.5 and 100 volts, constitutes a 'space' signal.

Input impedance of the EXT. ELECT. jacks is greater than 1 MΩ.

2.3 (continued)

Mechanical Keying

In mechanical keying, the contacts of an external keying device are used merely to complete the circuit from the T (tongue) terminal to the M (mark) and/or S (space) terminals.

The M and S terminals have the following internally-generated potentials :

M : -105 volts d.c.
S : -35 volts d.c.

Connecting T to M constitutes a 'mark' signal; connecting T to S constitutes a 'space' signal.

In double-current keying systems, M, T, and S are connected to the corresponding terminals on the polarized relay or other keying device. In single-current systems, e.g., simple hand key, T and S are connected across the keying contacts.

The keying arrangements are summarized in the following table.

ELEC. Keying Voltage	MECH. Connections	MARK or SPACE	OUTPUT SIGNAL on-off	OUTPUT SIGNAL F.S.K.
-100 to 0 volts (or no input)	T - M	MARK	No output	No shift
+3.5 to 100 volts	T - S	SPACE	Output	Shift

2.4 R.F. OUTPUT ARRANGEMENTS

2.4.1 Output Connector

The output of the Telegraph Test Generator is available at the R.F. OUTPUT plug. This is a Pye Miniature Plug Type 732564 (Joint-Services Ref. No. Z.540151) and mates with the Pye Miniature Cable

2.4.1. (continued)

Mounting Socket Type 732557 (Z.540155) provided. Suitable coaxial cables for use with this socket are Uniradio 32 or 70.

2.4.2. Output Controls

Three factors affect the output level from the Telegraph Test Generator:

(a) The SET CARRIER control, whose setting determines the input level to the attenuator cascade.

(b) The coarse or MULTIPLY E.M.F. BY attenuator.

(c) The fine or OUTPUT E.M.F. attenuator.

The SET CARRIER control is adjusted in conjunction with the CARRIER LEVEL meter, which monitors the input level to the coarse attenuator. The meter has three marks on its scale: -1 dB, 0, and +1 dB. Normally, the SET CARRIER control should be adjusted to bring the meter pointer to the zero mark; the calibration of the two attenuators is then correct at all settings. The SET CARRIER control and the CARRIER LEVEL meter also provide a means of interpolating between the steps of the fine attenuator.

The coarse or MULTIPLY E.M.F. BY attenuator has a total range of 80 dB variable in 20-dB steps; each setting of the attenuator control has markings in red and white. The red markings are in terms of decibels relative to 1 μV e.m.f., and the white markings are multiplying factors for the white markings on the fine attenuator.

The fine or OUTPUT E.M.F. attenuator has a total range of 20 dB variable in 1-dB steps; each setting of the attenuator control has markings in red and white. The red markings are in terms of decibels relative to 1 μV, and the white markings are directly in units of output e.m.f.

The combined calibration accuracy of the two attenuators is approximately ±1 dB ±0.2 μV. Both attenuators have a characteristic impedance of 75 ohms and, 'looking into' the R.F. OUTPUT plug, the instrument appears as a generator with a source impedance of 75 ohms.

2.4.2. (continued)

It should be noted particularly that the r.f. output controls on the Telegraph Test Generator are calibrated in terms of source e.m.f. or open-circuit output voltage and not in terms of the p.d. across an external load. To find the equivalent terminal p.d., see Section 2.4.4.

2.4.3. Outputs from 2 μV to 200 mV at 75 ohms

It is intended that the Telegraph Test Generator should normally be used with the SET CARRIER control adjusted to bring the meter pointer to the centre zero mark.

Used in this way, the instrument should be regarded as a source of zero impedance in series with a resistance of 75 ohms, the open-circuit output or source e.m.f. being variable in 1-dB steps from 2 μV to 200 mV, and being indicated as follows:-

(a) directly in terms of decibels relative to 1 μV, by the sum of the red settings of the OUTPUT E.M.F. and MULTIPLY E.M.F. BY attenuators.

(b) directly in voltage, by the product of the white settings of the OUTPUT E.M.F. and MULTIPLY E.M.F. BY attenuators.

It should be noted that the white voltage calibrations indicated by the attenuator controls are not directly applicable when the meter is set to other than the zero mark; with the meter at -1 dB, for example, the source e.m.f. at the R.F. OUTPUT plug is 0.89 times the indicated voltage; with the meter at the +1 dB mark, the source e.m.f. is 1.12 times the indicated voltage.

2.4.4. Outputs in Terms of the Voltage Developed Across an External Load

For some particular applications, it may be desired to work, not in terms of source e.m.f. as indicated by the meter and attenuator controls, but in terms of actual voltage developed across the external

2.4.4. (continued)

load; this on-load or terminal voltage is given by the expression

$$V_L = E \times \frac{Z_L}{75 + Z_L} \quad \ldots\ldots\ldots (1)$$

where V_L = actual voltage developed across the external load.

E = source e.m.f. of the instrument.

Z_L = impedance of the external load.

The expression is based on the assumption that the external load impedance, Z_L, is essentially resistive. Where this is not so, it may be necessary for the user to revise the expression to take account of the reactive component of the load.

In the normal case of a matching 75-ohm load, the terminal voltage is half the indicated e.m.f.

A series of multiplying factors, which can be used to convert from source e.m.f. to actual voltage developed across an external load, and which have been derived with the aid of the above expression, are given in TABLE 1 for a selection of typical load values.

TABLE 1

Load Z_L ohms	Voltage across Z_L is the indicated source e.m.f. multiplied by:-	Load Z_L ohms	Voltage across Z_L is the indicated source e.m.f. multiplied by:-
10	0.12	75	0.5
20	0.21	80	0.51
30	0.29	100	0.57
40	0.35	150	0.67
50	0.4	200	0.73
52	0.41	300	0.8
60	0.44	500	0.87
70	0.48	600	0.89

2.4.5. Increasing the Output Impedance

If it is necessary to present the equipment under test with a source impedance of more than 75 ohms, then the effective output impedance of the Generator can be increased to the required value, Z_R, by connecting a single resistor, R_A, in series with the R.F. OUTPUT plug. The value of the resistor which must be added is

$$R_A = Z_R - 75 \text{ ohms}$$

When a load, R_L, is connected to this arrangement,

$$\text{voltage across load} = \frac{E_S \times R_L}{75 + R_A + R_L}$$

where E_S is the source e.m.f. indicated by the two attenuators.

2.4.6. Reducing the Output Impedance

If it is necessary to present the equipment under test with a source impedance of less than 75 ohms, then the effective output impedance of the Generator can be made equal to the required value, Z_R, by shunting the R.F. OUTPUT plug to earth with a resistor, R_B, where

$$R_B = \frac{75 \times Z_R}{75 - Z_R} \text{ ohms}$$

Under these conditions, the effective source e.m.f., i.e. open-circuit voltage, is

$$E_{SE} = \frac{E_{SI} \times R_B}{75 + R_B} \text{ volts}$$

where E_{SI} is the source e.m.f. indicated by the two attenuators.

When a load R_L is connected to this arrangement, voltage

$$\text{across load} = \frac{E_{SE} \times R_L}{Z_R + R_L}$$

2.5. SETTING UP PROCEDURE

The following sections describe the methods of adjusting the Telegraph Test Generator to deliver a keyed r.f. signal at a carrier frequency of 3.1, 6.2, or 9.3 Mc/s, modulated either internally or externally by any one of the following keying systems:

(a) ON-OFF keying

(b) Frequency Shift Keying (FSK)

(c) Diplex or Twinplex Keying (DPX)

or with external sinewave amplitude modulation. Information on the keying input connections is given in Section 2.3.

A variable selective fading effect can be applied to the f.s.k. signal, reducing the level of the 'mark' (lower frequency) elements.

The r.f. output arrangements are described in Section 2.4, which also gives details of the method of matching the Generator output to loads other than 75 ohms.

When the coarse attenuator is switched to the fully clockwise position, i.e. maximum output, the CARRIER LEVEL meter reading will fall and the pointer should be restored to the zero mark with the aid of the SET LEVEL control. It is therefore advisable to check and readjust the setting of the CARRIER LEVEL meter each time the coarse attenuator is switched to or from the fully-clockwise, 80-dB, position.

2.5.1. ON-OFF Keying

(a) On-off - Internal

The internally derived keying signal is locked to the mains supply frequency and has a keying speed of 100 bauds for 50-c/s supplies:

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK and the SHIFT control to minimum in order to provide an unkeyed output signal.

.5.1. (continued)

(3) Set the FADING ON/OFF switch to OFF.

(4) Turn the INT/EXT switch to INT.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See Section 2.4.2.)

(7) Turn the Keying Selector to ON-OFF (CW).

Note: With on-off keying applied, the mean level of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading.

In on-off keying the SHIFT control has no effect. The FADING control is intended for use only with f.s.k.; it will, however, affect the amplitude of the output signal on on-off keying.

(b) On-off - External Electrical

Methods of connection for external electrical keying are described in Section 2.3 - KEYING INPUT ARRANGEMENTS.

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK and the SHIFT control to minimum in order to provide an unkeyed output signal.

(3) Set the FADING ON/OFF switch to OFF.

(4) Turn the INT/EXT switch to EXT.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See section 2.4.2.)

.5.1. (continued)

(7) Turn the Keying Selector to ON-OFF (CW).

(8) Connect the output from the test sender to the front-panel telephone-jack - EXT. ELEC. A - using the jack-plug provided.

Note: With on-off keying applied, the mean level of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading.

In on-off keying the SHIFT control has no effect. The FADING control is intended for use only with f.s.k.; it will, however, affect the amplitude of the output signal on on-off keying.

(c) On-off - External Mechanical

Methods of connection for external mechanical keying are described in Section 2.3 - KEYING INPUT ARRANGEMENTS.

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK and the SHIFT control to minimum in order to provide an unkeyed output signal.

(3) Set the FADING ON/OFF switch to OFF.

(4) Turn the INT/EXT switch to MECH.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See Section 2.4.2.)

(7) Turn the Keying Selector to ON-OFF (CW).

(8) Connect the contacts of the keying device to the front-panel terminals EXT. MECH. - CHANNEL A.

5.1. (continued)

Note: With on-off keying applied, the mean level of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading.

In on-off keying the SHIFT control has no effect. The FADING control is intended for use only with F.S.K.; it will, however, affect the amplitude of the output signal on on-off keying.

5.2. Frequency Shift Keying

(a) F.S.K. - Internal

The internally derived keying signal is locked to the mains supply frequency and has a keying speed of 100 bauds for 50-c/s supplies. Frequency shift is indicated on a dial calibrated at 50-c/s intervals and is variable up to 1300 c/s.

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK.

(3) Turn the INT/EXT switch to INT.

(4) Set the FADING ON/OFF switch to OFF.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See Section 2.4.2.)

(7) Adjust the SHIFT control to the required value.

(8) Set the FADING ON/OFF switch to ON or OFF as required. With FADING ON, the amplitude of the lower-frequency or unshifted signal can be reduced, by means of the front-panel FADING control, from its normal value to any level down to zero.

5.2. (continued)

Note: With fading applied, the mean level of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading.

(b) F.S.K. - External Electrical

Methods of connection for external electrical keying are described in Section 2.3 - KEYING INPUT ARRANGEMENTS.

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK.

(3) Turn the INT/EXT switch to EXT.

(4) Set the FADING ON/OFF switch to OFF.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See Section 2.4.2.)

(7) Connect the output from the test sender to the front-panel telephone-jack - EXT. ELEC. A - using the jack-plug provided.

(8) Adjust the SHIFT control to the required value.

(9) Set the FADING ON/OFF switch to ON or OFF as required. With FADING ON, the amplitude of the lower-frequency or unshifted signal can be reduced, by means of the front-panel FADING control, from its normal value to any level down to zero.

Note: With fading applied, the mean level of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading.

2.5.2. (continued)

(c) F.S.K. - External Mechanical

Methods of connection for external mechanical keying are described in Section 2.3 - KEYING INPUT ARRANGEMENTS.

(1) Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s as required.

(2) Turn the Keying Selector to FSK.

(3) Turn the INT/EXT switch to MECH.

(4) Set the FADING ON/OFF switch to OFF.

(5) Adjust the SET CARRIER control to bring the meter pointer to the 0 dB mark.

(6) Adjust the two attenuator controls to obtain the required output. (See Section 2.4.2.)

(7) Connect the contacts of the keying device to the front-panel terminals, EXT. MECH - CHANNEL A.

(8) Adjust the SHIFT control to the required value.

(9) Set the FADING ON/OFF switch to ON or OFF as required. With FADING ON, the amplitude of the lower-frequency or unshifted signal can be reduced, by means of the front-panel FADING control, from its normal value to any level down to zero.

Note: With fading applied, the mean value of the r.f. output decreases and the CARRIER LEVEL meter reading will fall accordingly. Do not readjust the SET CARRIER control in order to restore the original meter reading

2.5.3. Diplex (Twinplex) Keying

For Diplex operation, two independent keying signals are applied to the Test Generator. The two signal sources may be

(i) both external mechanical

2.5.3. (continued)

(ii) both external electrical

(iii) both external, one mechanical and one electrical

(iv) one internal, and one external mechanical or electrical

(i) When using dual external mechanical keying, set up as for f.s.k. external mechanical, but turn the Keying Selector to DPX. Connect the second keying line to the EXT. MECH - CHANNEL B terminals.

(ii) When using dual external electronic keying, set up as for f.s.k. external electrical, but turn the Keying Selector to DPX. Connect the second keying line to the EXT. ELEC. B telephone-jack via the jack-plug provided.

(iii) When using mixed external keying (one mechanical and one electrical) set up as for f.s.k. but turn the Keying Selector to DPX and turn the INT/EXT switch to the appropriate position for the Channel A input.

(iv) When using one internal and one external keying signal, set up as for f.s.k., internal, but turn the Keying Selector to DPX. The external keying line must be connected to the CHANNEL B jack or CHANNEL B terminals; the internal keying constitutes Channel A.

The two channels may be combined according to either the Code 1 or Code 2 systems (see Section 1.2.2.3.) by means of the CODE 1/ CODE 2 front-panel switch. The fading facility is not applicable, and therefore the FADING ON/OFF switch should be at OFF.

The SHIFT control indicates the total frequency shift from the original carrier frequency selected, i.e. the shift of the f_4 element.

2.5.4. External Sinewave Amplitude Modulation

The Telegraph Test Generator can be set up to deliver an amplitude modulated r.f. signal at any of the three carrier frequencies. Inserting the plug in the EXT. MOD. jack-socket automatically produces

2.5.4. (continued)

an uninterrupted c.w. output at any combination of the Keying Selector and INT/EXT switch positions. The carrier level is lower than that used for keying, and the calibration of the coarse and fine attenuators is, therefore, no longer valid.

The external modulating signal is applied by way of the EXT. MOD. front-panel telephone jack via the jack-plug provided. An external sinewave signal of about 20 volts r.m.s. will produce 100% modulation. The frequency of the external modulating signal can be varied between 25 c/s and 500 c/s. The input is a.c. coupled.

OPERATIONAL SUMMARY

When the user is familiar with the principles and techniques of operation detailed in Section 2, the following abridged instructions may be found a convenient guide for quick reference.

Carrier Frequencies

3.1, 6.2, and 9.3 Mc/s

Output E.M.F.

2 μV to 200 mV

Output Impedance

75 ohms

Modulation

On-off keying.
FSK and Diplex: max. shift, 1,300 c/s.
External sine a.m., up to 100%.

Keying Speed

Internal elec., 100 bauds.
External elec. or mech., up to 500 bauds.

Power Supply

100 to 150 volts and 200 to 250 volts
40 to 100 c/s.

BEFORE SWITCHING ON

Be sure that the mains transformer tappings are correctly set.

PRELIMINARY CARRIER ADJUSTMENTS

Set the FREQUENCY switch to 3.1, 6.2, or 9.3 Mc/s. Turn the Keying Selector to FSK and the SHIFT control to minimum. Set the FADING ON/OFF switch to OFF. Adjust the SET CARRIER control for CARRIER LEVEL meter zero, and adjust the two attenuators for the required output.

ON-OFF - Internal

Turn the Keying Selector to ON-OFF (CW) and the INT/EXT switch to INT.

(continued)

ON-OFF - External Electrical

Turn the Keying Selector to ON-OFF (CW) and the INT/EXT switch to EXT. Apply keying signal to the EXT. ELEC. A jack.

ON-OFF - External Mechanical

Turn the Keying Selector to ON-OFF (CW) and the INT/EXT switch to MECH. Connect the keying contacts to the EXT. MECH. - CHANNEL A terminals.

F.S.K. - Internal

Turn the Keying Selector to FSK and the INT/EXT switch to INT. Adjust the SHIFT control to the required value. Switch on and adjust FADING if required.

F.S.K. - External Electrical

Turn the Keying Selector to FSK and the INT/EXT switch to EXT. Apply keying signal to the EXT. ELEC. A jack. Adjust SHIFT control to the required value. Switch on and adjust FADING if required.

F.S.K. - External Mechanical

Turn the Keying Selector to FSK and the INT/EXT switch to MECH. Connect the keying contacts to the EXT. MECH. - CHANNEL A terminals. Adjust SHIFT control to the required value. Switch on and adjust FADING if required.

DIPLEX (TWINPLEX) KEYING - Dual External Mechanical

Set up as for FSK - EXT. MECH. Turn the Keying Selector to DPX. Connect the second keying line to the EXT. MECH. - CHANNEL B terminals, switch to CODE 1 or CODE 2 as required. Set FADING ON/OFF switch to OFF.

DIPLEX (TWINPLEX) KEYING - Dual External Electrical

Set up as for FSK - EXT. ELEC. Turn the Keying Selector to DPX. Connect the second keying line to the EXT. ELEC. B jack. Switch to CODE 1 or CODE 2 as required. Set FADING ON/OFF switch to OFF.

(continued)

DIPLEX (TWINPLEX) KEYING - Mixed External

Set up as for FSK but turn the INT/EXT switch to the appropriate position for the Channel A input. Turn the Keying Selector to DPX. Switch to CODE 1 or CODE 2 as required. Set FADING ON/OFF switch to OFF.

DIPLEX (TWINPLEX) KEYING - 'A' Internal, 'B' External

Set up as for FSK - Internal. Turn the Keying Selector to DPX. Connect the external keying line to the EXT. ELEC. B jack or EXT. MECH. - CHANNEL B terminals as appropriate. Switch to CODE 1 or CODE 2 as required. Set the FADING ON/OFF switch to OFF.

EXTERNAL SINEWAVE

Apply the modulating signal by way of the EXT. MOD. front-panel jack. A 10-volt, 25-to-500-c/s signal will produce approximately 100% modulation.

4. MAINTENANCE

4.1. GENERAL

The following items (for details see APPENDICES, page 58) are included in this handbook to assist in the maintenance of the Telegraph Test Generator Type TF 1167:-

Functional Diagram
Complete Circuit Diagrams
Component Layout Illustrations
Spares Ordering Schedule with
Circuit References
Valve Replacement Data Sheets

Section 1, DESCRIPTION, in this handbook deals with the performance and internal circuits of the Telegraph Test Generator and it is strongly recommended that the user should familiarize himself with this information before commencing the adjustment or replacement of components parts of the instrument.

The Circuit Diagrams show all electrical components contained in the instrument. The description of these components - their type, value, rating etc. - is given in the Spares Ordering Schedule; the Schedule also lists certain selected mechanical components.

The physical location of the electrical components is shown by the Component Layout Illustrations.

4.2. FUSE REPLACEMENT

The circuits of the Telegraph Test Generator are protected by four fuses as follows:-

(1) One 2-amp fuse in series with the 'line' input connection to the mains transformer, (FS1); this fuse is adequately rated for both the 200- to 250-volt and 100- to 150-volt ranges of the transformer.

(2) One 250-mA fuse in series with the 230-volt positive h.t. line (FS2).

(3) One 250-mA fuse in series with the 140-volt negative h.t. line (FS3).

4.2. (continued)

(4) One 15-amp fuse in series with the l.t. supply (FS4).

The four fuse holders are mounted on the front panel of the Power Unit.

4.3. MAINS INPUT ARRANGEMENTS

The mains transformer is suitable for operation from 40- to 100-c/s supply voltages within the ranges 200 to 250 and 100 to 150 volts. The instrument is normally dispatched ready for operation from a 240-volt supply, and adjustment to suit other supply voltages can be made by altering the primary connections to the mains transformer.

This transformer has a double-wound primary, whose two tapped sections are connected in series for the 200- to 250-volt range, or in series-parallel for the 100- to 150-volt range. The procedure for changing voltage ranges or for adjustment of voltages within these ranges is described below.

Before making any adjustments, make sure that the mains plug is disconnected from the supply.

(a) To change from one voltage range to the other, i.e. from the 200- to 250-volt range to the 100- to 150-volt range or vice-versa, first take off the Power Unit dust cover after removing the four BA screws securing it to the rear of the unit; then link the appropriate solder tags on the mains transformer coil as follows:-

(i) For the 200- to 250-volt range, connect a single soldered link between the tags marked 'Tap A' and 'Tap B'. Remove any other links. Reverse the reference plate on the mains tapping panel at the rear of the instrument to reveal the side marked with the voltages appropriate to the 200- to 250-volt range.

(ii) For the 100- to 150-volt range, connect a soldered link between the two tags marked 'Tap A' and '200' respectively and a separate link between tne two tags marked 'Tap B' and '0' respectively, taking care that there is no risk of these two links shorting together. Remove any other links.

3. (continued)

Reverse the reference plate on the mains tapping panel at the rear of the instrument to reveal the side marked with the voltages appropriate to the 100- to 150-volt range.

(b) To change from one intermediate voltage to another, e.g. from 240 to 210 volts, it is not necessary to remove the Power Unit dust cover since adjustment is made entirely at the mains tapping panel. The tapping panel is accessible through a cut-out in the dust cover at the rear of the instrument. Reposition the two screw-secured fly-leads to the tapping points that give a combination to suit the required voltage. For example, take the leads to the tapping points marked '240' and '0' respectively for a 240-volt supply, or to '200' and '+10' for a 210-volt supply.

4. REMOVAL OF COVERS

The complete equipment divides physically into two units, each suitable for mounting in a standard 19-inch rack.

To remove the dust cover from either unit:

(1) Lay the unit face downwards, resting on the panel rails.

(2) Extract the four 4 BA screws securing the cover to the rear of the unit.

(3) Lift the dust cover clear of the instrument.

5. ACCESS TO SUB-ASSEMBLIES

In maintaining or servicing the Telegraph Test Generator, the user may need to obtain access to the interior of one of the sub-assemblies which form part of the instrument. The procedures for this purpose are detailed in the following sections.

5.1. R.F. Section

Components in the r.f. section mounted above the main chassis are enclosed in a black screening cover. To remove this cover, extract the nine 4 BA screws securing it to the main chassis.

5.1. (continued)

Components in the r.f. section mounted below the main chassis are enclosed in the r.f. box. To remove the square plate forming the base of the r.f. box, lay the instrument upside down with the front panel vertical and extract the eighteen 4 BA screws from around the outer edge of the base plate.

The interior of the r.f. box is shown in Component Layout Illustration MP 1167 - 4.

5.2. Oscillator Coil Assembly

The interior of the oscillator coil assembly is shown in Component Layout Illustration MP 1167 - 2.

The oscillator coil assembly, including L5, C14 to C17 inclusive, R14 and R15, is situated within the screened r.f. compartment. It is fitted with a cover secured to the main chassis by two eye-bolts and nuts. To obtain access to these components:-

(1) Remove the dust cover from the Test Generator as described in Section 4.4.

(2) Remove the r.f. screening cover and base plate as described in Section 4.5.1.

(3) With the instrument remaining upside down, unscrew the two 4 BA nuts securing the oscillator coil assembly cover to the main chassis. The location of these two nuts is shown on MP 1167 - 4.

5.3. Fine Attenuator

The location of the fine or OUTPUT E.M.F. attenuator is shown in Component Layout Illustration MP 1167 - 3. To dismantle the attenuator, proceed as follows:-

(1) Remove the attenuator screening cover after extracting the single retaining screw.

(2) Remove the front-panel control knob after slackening the two grub screws which secure it to its spindle.

.5.3. (continued)

(3) Detach the main body of the attenuator from the front panel by extracting the five retaining screws; three of these screws are immediately visible on removal of the control knob as in (2) above; the two remaining screws are located immediately above and to the left of the fine attenuator panel markings.

With the attenuator detached as in (3) above, it remains coupled to the body of the instrument by two coaxial leads; these leads are normally sufficiently long to permit inspection and, if necessary, replacement of the attenuator resistors without completely disconnecting the attenuator.

Replace the fine attenuator in the reverse order to that detailed above.

.5.4. Coarse Attenuator

The coarse or MULTIPLY E.M.F. BY attenuator comprises two main compartments: a rear compartment containing the meter rectifier assembly, including XL2, C34, C35 and R71, and a forward compartment containing the resistors which compromise the coarse attenuator proper. The location of the coarse attenuator is shown in Component Layout Illustration MP 1167 - 3.

Access to the crystal rectifier, XL2, and its associated filter components is obtained by carrying out operations (1) and (2) detailed below; by following the entire procedure, the whole coarse attenuator assembly can be detached from the front panel of the instrument.

(1) Disconnect the lead from the feed-through pillar which projects through the rear compartment by removing the 8 BA nut and washer.

(2) Remove the meter-rectifier screening cover by extracting the three screws securing it to the coarse attenuator screening cover.

(3) Remove the coarse attenuator screening cover after extracting its single retaining screw.

4.5.4. (continued)

(4) Remove the front-panel control knob after slackening the two grub screws securing it to the spindle.

(5) Detach the main body of the attenuator from the front panel by extracting the five fixing screws; three of these screws are immediately visible on removing the control knob as in (4), the two remaining screws are located immediately above and to the right of the coarse attenuator panel markings.

With the attenuator detached as in (5) above, it remains coupled to the body of the instrument by two coaxial cables. These cables are, however, normally long enough to permit inspection and, if necessary, replacement of the attenuator resistors without completely disconnecting the attenuator.

4.6. WORKING VOLTAGES

The voltages given in this section for guidance when servicing the instrument were obtained from a representative Telegraph Test Generator and associated Power Unit; the voltmeter used was an Avometer model 8, which has a resistance of 20,000 ohms per volt.

Measurements were made with the mains transformer tapping set to 240 volts and using a 240-volt supply.

Except where otherwise indicated, the Telegraph Test Generator controls were set as follws:-

FREQUENCY Switch to 3.1 Mc/s
Keying Selector to FSK
INT/EXT Switch to EXT.
FADING Switch to OFF
SET CARRIER Control adjusted for 0 dB on the CARRIER LEVEL meter
No external keying applied

6. (continued)

Power Supply Voltages

TABLE 2

Supply	Measured Between:-	Voltage
L.T. a.c.	L.T. tags on T1	6.6 V a.c.
H.T.1 a.c.	H.T.1 tags on T1	260 V a.c.
H.T.2 a.c.	H.T.2 tags on T1	430 V a.c.
H.T.1 Smoothed	Across R2	+310 V d.c.
H.T.2 Smoothed	Across R4	+470 V d.c.
H.T.1 Stabilized	Pin 4 and Pin 2 of V1	+140 V d.c.
H.T.2 Stabilized	Pin 2 and Pin 3 of V2	-140 V d.c.
H.T.3 Stabilized	Pin 4 and Pin 3 of V2	+70 V d.c.
H.T.4 Stabilized	Pin 5 and Pin 3 of V2	-70 V d.c.

Valve Electrode Voltages(R.F. Unit)

Table 3 shows d.c. electrode voltages with respect to chassis. These are given for guidance in servicing the instrument; between individual instruments some variation in electrode voltages may be expected due to normal tolerances of valve performance and component values.

. 6. (continued)

TABLE 3

Valve No.	Anode Volts d.c.	Screen Volts d.c.	Cathode Volts d.c.
V1	135	135	2.2.
V2b	120	-	60
V3	180	105	1.0
V4	295	90	1.0
V5a	130	-	-67
V5b	60	-	-67
V6a	-20	-	-67
V6b	67	-	20
V10a	67	-	*-68
V10b	67	-	1.0.
V11a	0	-	0.1
V11b	0.1	-	16.5
V12a	-45	-	-65
V12b	45	-	-65

* Measured with the FADING switch to ON and the FADING control fully anti-clockwise.

. 7. REPLACEMENT OF VALVES AND CRYSTALS

The types of valve used in the instrument, their base connections, and some guidance as to suitable alternatives if the types normally fitted are not readily available, are given in the Valve Replacement Data Sheets.

The valves and crystals may normally be replaced without special selection and are immediately accessible on removing the dust covers and the r.f. screening cover as described in Section 4.5 and 4.5.1.

7. (continued)

Replacement of valves may necessitate either the reselection of associated components or readjustment of associated preset controls.

Table 4 shows a list of valves whose replacement is most likely to necessitate readjustment or reselection of associated components together with the numbers of the sections in which this adjustment or selection is described. It is good practice to age new valves for at least 72 hours before final reselection or readjustment.

TABLE 4

GENERATOR UNIT

Valve No.	Sect. No.	Valve No.	Sect. No.
V1 & V2	4.9.4.	V7	4.9.12.
V4	4.9.5.	V8	4.9.12.
XL1	4.9.4.	V9	4.9.12.
		V10	4.9.8.

POWER UNIT

Valve No.	Sect. No.
V2*	4.9.12.

* Changing the voltage stabilizer V2 is likely to alter the level of the 70-volt h.t. lines and hence the level of the voltage applied across the chain of preset resistors associated with the diode gating circuit. It is therefore necessary, if the diplex output waveform is not to be impaired, to readjust the diode gating circuit preset controls after replacement of V2.

4.8. PRESET AND SPECIALLY SELECTED COMPONENTS

In the manufacturing data for the Telegraph Test Generator, certain of the components are either specified as being of the preset type or designated for individual selection, the setting or selection of the components being carried out during the factory calibration of the instrument; this is necessary since the operating characteristics of the instrument have to conform to a quantitative specification including both maximum and minimum limits.

If, in servicing the instrument, it is necessary to replace any of these components, it is also necessary, if the performance or accuracy of the instrument is not to be impaired, to repeat the factory procedure by which the component was originally adjusted or selected.

Again, in any servicing involving the replacement of a valve, or a component which is neither preset nor selected, the user should consider carefully the possible effect on the performance of the circuit involved; if the performance has been set previously by means of a preset or selected component, it may be necessary to readjust or reselect that component in addition to replacing the faulty one.

Section 4.9 contains a range of tests by which the main points of the performance of the instrument can be checked; this section also deals with the adjustment of preset components and with the choice of value for individually selected components. TABLE 5 lists the circuit reference numbers of both types of component together with the numbers of the subsidiary sections in which their adjustment or selection is described.

Components which are individually selected are distinguished in the Description column of the Spares Ordering Schedule and in the Circuit Diagram by a single asterisk.

4.8. (continued)

TABLE 5

Selected Component	Section Describing Selection	Preset Component	Section Describing Adjustment
R4	4.9.10.	RV2	4.9.12.
R5	4.9.10.	RV3	4.9.12.
R6	4.9.10.	RV4	4.9.12.
		RV5	4.9.12.
R48	4.9.13.	RV6	4.9.9.
R117	4.9.7.	L6	4.9.4.
R118	4.9.8.	L7	4.9.6.
R27	4.9.9.	C20	4.9.4.
R43	4.9.12.	C27	4.9.5.
R47	4.9.13.	C29	4.9.5.
C32	4.9.5.	C31	4.9.5.

4.9. SCHEDULE OF TESTS

The following information, based on abstracts from the internal Factory Test Schedule, TS 1167, is included to enable the user to carry out a series of tests by which the main points of performance of the instrument can be checked; it also gives details concerning the adjustment of preset components and the choice of value for individually selected components.

4.9.1. Apparatus required

(a) Multi-Range Volt/Ammeter, e.g. Avometer model 8.

(b) Variable Mains Transformer, e.g. Variac.

(c) 75-ohm Resistive Load.

(d) A.C. Valve Voltmeter, e.g. Marconi Types TF 428 (Series), TF 958, or TF 1041 (Series).

4.9.1. (continued)

(e) Frequency Meter with an accuracy of at least 1 part in 10^6, e.g. Marconi Type OA 1071 with TF 922/2, or Type TME 2.

(f) Cathode-Ray Oscilloscope, 10-Mc/s Bandwidth, 10 mV sensitivity.

(g) Cathode-Ray Oscilloscope, Double Beam.

(h) A.C. Valve Millivoltmeter, e.g. Marconi Types TF 1100 or TF 899.

(i) 3-Mc/s Oscillator, such as used on h.f. communication receivers or transmitter drive units.

(j) Crystal Mixer, for use with item (i); also 100-kc/s beat-note amplifier.

(k) High Discrimination Oscillator, 98 to 102 kc/s, e.g. Marconi Type TF 1168.

(l) Beat Frequency Oscillator, 20 to 500 c/s, e.g. Marconi Type TF 195 (Series).

(m) Square Wave Oscillator, 200 c/s, e.g. Marconi Type TF 885 (Series).

(n) 75-ohm Variable Attenuator, 0 - 100 dB, e.g. Marconi Type TF 1073.

(o) Sensitive Receiver, 3 to 9.5 Mc/s, with output meter.

4.9.2. Measurement of Mains Variation Effects

(Apparatus required: Items a and b)

(1) Connect the Power Unit to the Telegraph Test Generator via the two interconnecting cableforms.

(2) Connect the Power Unit to the mains supply via the Variac transformer.

(3) Set the Variac to deliver an output voltage exactly equal to that for which the mains transformer tapping panel is adjusted.

4.9.2. (continued)

(4) Check that all Power Unit voltages are in close agreement with those given in Section 4.6.

(5) Vary the output voltage from the Variac by ±5% and check that all voltages measured in (4) do not vary by more than about ±1%.

4.9.3. Measurement of Hum Level on H.T.

(Apparatus required: Items a, b, and g)

(1) Connect the Power Unit to the Telegraph Test Generator via the two interconnecting cableforms.

(2) Connect the Power Unit to the mains supply via the Variac transformer.

(3) Set the Variac to deliver an output voltage exactly equal to that for which the mains transformer tapping panel is adjusted.

(4) Couple the oscilloscope to the +300-volt h.t. line (pin 1 of SK1) via a suitable isolating capacitor, and examine the ripple waveform; its peak-to-peak amplitude should not exceed about 10 mV.

4.9.4. Oscillator Tuning (Apparatus required: Item h)

The oscillator tuning procedure consists of adjusting the frequency of the L-C oscillator to coincide with the series-resonant frequency of the crystal XL1.

(1) Turn the FREQUENCY switch to 3.1-Mc/s and the Keying Selector to ON-OFF (CW).

(2) Check that L6 is at maximum inductance, i.e. core fully in.

(3) Connect the valve voltmeter across the crystal, XL1, and adjust preset capacitor C20 for minimum valve voltmeter reading.

4.9.5. Output Amplifier Tuning (Apparatus required: Items c and d)

The anode circuit of the output amplifier, V4, is tuned at each of the three output frequencies by means of preset capacitors C27, C29, and C31.

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to FSK
INT/EXT switch to EXT.
FADING switch to OFF

(2) Turn both attenuator controls fully clockwise and adjust the SET CARRIER control for centre zero on the CARRIER LEVEL meter.

(3) Terminate the R.F. OUTPUT plug, PL3, with the 75-ohm load and connect the valve voltmeter across this load.

(4) Adjust preset capacitor C31 and, if necessary, select a value for C32 for maximum valve voltmeter reading, readjusting the SET CARRIER control to restore the 0 dB meter reading.

(5) Turn the FREQUENCY switch to 6.2 Mc/s and adjust preset capacitor C29 for maximum valve voltmeter reading.

(6) Turn the Frequency switch to 9.3 Mc/s and adjust preset capacitor C27 for maximum valve voltmeter reading.

4.9.6. Adjustment of Acceptor Circuit (Apparatus required: Items c and f)

The acceptor circuit coil, L7, is adjusted to minimize the effect of 6.2-Mc/s breakthrough on the 9.3-Mc/s carrier.

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 9.3 Mc/s
Keying Selector to FSK
INT/EXT switch to EXT.
FADING switch to OFF
SHIFT control to minimum

4.9.6. (continued)

(2) Terminate the R.F. OUTPUT plug, PL3, with the 75-ohm load and connect the oscilloscope (Y plate) to this load.

(3) Adjust L7 for minimal a.m. on the output waveform.

4.9.7. Setting up the Output Level (Apparatus required: Items c and h)

The value of the CARRIER LEVEL meter shunt resistor, R117, is selected so that the attenuator calibrations are correct when the meter reads 0 dB.

(1) Set the front-panel controls as follows:-

FREQUENCY switch	to 3.1 Mc/s
Keying Selector	to FSK
INT/EXT switch	to EXT.
FADING switch	to OFF

(2) Terminate the R.F. OUTPUT plug, PL3, with the 75-ohm load and connect the valve millivoltmeter across this load.

(3) Turn both attenuator controls fully clockwise.

(4) Adjust the SET CARRIER control for a millivoltmeter reading of 100 mV.

(5) Select a value of R117 to bring the pointer of the CARRIER LEVEL meter to the 0 dB mark.

(6) Check that the actual r.f. output level at each setting of the attenuator controls is accurate to within ±1 dB ±0.2 μV.

4.9.8. Adjustment of F.S.K. 'Mark' Frequency
(Apparatus required: Items f, i, j and k)

The frequency of the F.S.K. 'mark' signal is adjusted to be equal to the on/off keying carrier frequency, as set in Section 4.9.4, by selecting the value of R118.

9.8. (continued)

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to ON-OFF (CW)
INT/EXT switch to INT. CH.A
FADING switch to OFF
SHIFT control fully clockwise

(2) Connect the output of the Telegraph Test Generator and the output of the 3-Mc/s oscillator (item i) into the mixer (item j).

(3) Connect the mixer output to the oscilloscope (Y plate) and the output of the High Discrimination Oscillator (item k) to the oscilloscope (X plate).

(4) Tune the High Discrimination Oscillator until a Lissajous circle appears on the oscilloscope, indicating a 1:1 frequency ratio.

(5) Turn the Telegraph Test Generator Keying Selector to FSK and, without adjusting the High Discrimination Oscillator controls, select a value for R118 to restore the 1:1 frequency ratio.

Since the frequency of an f.s.k. signal alternates between two values, the 'mark' Lissajous circle will be superimposed on a complex background pattern due to the 'space' signal.

To ensure that this Lissajous circle is caused by the 'mark' (lower frequency) and not by the 'space' (high frequency) signal, check that a second circle can be obtained by increasing the High Discrimination Oscillator frequency by about 1300 c/s.

9.9. Adjustment of Maximum 'Space' Shift

(Apparatus required: Items f, i, j and k)

The full scale frequency shift of the F.S.K. 'space' element is adjusted to 1,200 c/s relative to the 'mark' frequency by means of the preset potentiometer RV6 (the SET FREQ. SHIFT control).

4.9.9. (continued)

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to FSK
INT/EXT switch to INT. CH.A
FADING switch to OFF
SHIFT control to 1200 c/s

(2) Connect the output of the Telegraph Test Generator and the output of the 3-Mc/s oscillator (item i) into the mixer (item j).

(3) Connect the mixer output to the oscilloscope (Y plate) and the output of the High Discrimination Oscillator (item k) to the oscilloscope (X plate).

(4) Tune the High Discrimination Oscillator until a Lissajous circle appears on the oscilloscope. Ensure that this Lissajous circle is due to the 'mark' signal (see Section 4.9.8).

(5) Increase the High Discrimination Oscillator frequency by 1,200 c/s and adjust preset potentiometer RV6 and, if necessary, select a value for R27 until a Lissajous circle appears on the oscilloscope.

4.9.10. Adjustment of Frequency Shift Ratio at 6.2 and 9.3 Mc/s
(Apparatus required: Items f, i, j and k)

The amplitude of the keying signal applied to the reactance valve is divided by a factor of 2 when switched to 6.2 Mc/s and a factor of 3 when switched to 9.3 Mc/s. The division ratio is set by selecting the values for R4, R5 and R6 that produce shift ratios of 1, 1/2, and 1/3 respectively, at the input of the harmonic multiplier stage.

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 6.2 Mc/s
Keying Selector to FSK
INT/EXT switch to INT. CH.A
FADING switch to OFF
SHIFT control fully clockwise

9.10. (continued)

(2) Feed the output from the buffer amplifier - pin 2 of V4 - and the output of the 3-Mc/s oscillator (item i) into the mixer (item j).

(3) Connect the mixer output to the oscilloscope (Y plate) and the output of the High Discrimination Oscillator (item k) to the oscilloscope (X plate).

(4) Tune the High Discrimination Oscillator until a Lissajous circle appears on the oscilloscope. Ensure that this circle is due to the 'mark' (lower frequency) signal. Note the High Discrimination Oscillator Frequency.

(5) Increase the High Discrimination oscillator frequency by 675 c/s and select a value of R5 to obtain a Lissajous circle on the oscilloscope.

(6) Turn the FREQUENCY switch to 9.3 Mc/s.

(7) Reduce the High Discrimination Oscillator frequency by 225 c/s and select a value for R6 to obtain a Lissajous circle on the oscilloscope.

(8) Retune the High Discrimination Oscillator to the frequency noted in (4) and, if necessary, select a value for R4 to obtain a Lissajous circle. Repeat steps (5), (6), (7).

9.11. Calibration of SHIFT Dial (Apparatus required: Items f, i, j and k)

The SHIFT control is calibrated in terms of the 'space' shift relative to the 'mark' frequency in 50-c/s increments from 0 to 1,300 c/s. This section deals with the method of checking the calibration accuracy and of replacing and recalibrating a new dial.

(1) Set the front-panel controls as follows:-

FREQUENCY switch	to 3.1 Mc/s
Keying Selector	to FSK
INT/EXT switch	to INT. CH.A.
FADING switch	to OFF

9.11. (continued)

(2) Connect the output of the Telegraph Test Generator and the output of the 3-Mc/s oscillator (item i) into the mixer (item j).

(3) Connect the mixer output to the oscilloscope (Y plate) and the output of the High Discrimination Oscillator (item k) to the oscilloscope (X plate).

(4) Tune the High Discrimination Oscillator until a Lissajous circle appears on the oscilloscope. Ensure that this circle is due to the 'mark' (lower frequency) signal.

(5) Adjust the SHIFT control until the 'space' signal frequency coincides with that for 'mark'. Note the position of the SHIFT dial which should be at or near zero.

(6) Increase the High Discrimination Oscillator frequency in 50-c/s increments, adjusting the SHIFT control to obtain a Lissajous circle on the oscilloscope at each increment. Take particular care that the circle is due to the 'space' (higher frequency) element. Check the accuracy of the dial calibration or note the position of the dial at each increment.

Compile a correction chart from the observations made in (5) and (6) or recalibrate a new dial as follows:-

(1) Fit a blank dial and repeat steps (1) to (6), marking the dial at each 50-c/s increment.

(2) Remove the dial, after marking it in such a manner that it may be refitted in the correct position after engraving.

(3) Engrave and refit dial; check accuracy.

9.12. Setting Up the Diode Gating Circuit

(Apparatus required: Items f, i, j and k)

By means of the four preset potentiometers, RV2 to RV5, the discrete amplitudes of the stepped waveform derived from the diode gating circuit are adjusted to produce oscillator frequency shifts of 0, 400, 800, and 1,200 c/s relative to the 'mark' frequency.

4.9.12. (continued)

(1) Set the front-panel controls as follows:-

FREQUENCY switch	to 3.1 Mc/s
Keying Selector	to FSK
INT/EXT switch	to INT. CH.A.
FADING switch	to OFF
SHIFT control	to zero

(2) Connect the output of the Telegraph Test Generator and the output of the 3-Mc/s oscillator (item i) into the mixer (item j).

(3) Connect the mixer output to the oscilloscope (Y plate) and the output of the High Discrimination Oscillator to the oscilloscope (X plate).

(4) Tune the High Discrimination Oscillator until a Lissajous circle appears on the oscilloscope. Ensure that this circle is due to the 'mark' (lower frequency) signal.

(5) Without altering the High Discrimination Oscillator setting, turn the Keying Selector to DPX, the CODING switch to CODE 1 and adjust the SHIFT control to 1200 c/s.

(6) Join the front-panel EXT. MECH. terminals as follows:-

T to S on CHANNEL A
T to M on CHANNEL B

(7) Adjust preset potentiometer RV5 until a Lissajous circle appears on the oscilloscope.

(8) Reconnect the front-panel EXT. MECH. terminals as follows:-

T to S on CHANNEL A
T to S on CHANNEL B

(9) Increase the High Discrimination Oscillator frequency by 400 c/s and adjust preset potentiometer RV4 until a Lissajous circle appears on the oscilloscope.

4.9.12. (continued)

(10) Reconnect the front-panel EXT. MECH. terminals as follows:-

T to M on CHANNEL A
T to S on CHANNEL B

(11) Increase the High Discrimination Oscillator frequency by 400 c/s and adjust preset potentiometer RV3 until a Lissajous circle appears on the oscilloscope.

(12) Reconnect the front panel EXT. MECH. terminals as follows:-

T to M on CHANNEL A
T to M on CHANNEL B

(13) Increase the High Discrimination Oscillator frequency by 400 c/s and adjust preset potentiometer RV2 and, if necessary, select a value for R43 until a Lissajous circle appears on the oscilloscope.

4.9.13. Adjustment of External Amplitude Modulation Depth (Apparatus required: Items f and l)

The adjustment procedure consists of selecting the pair of resistors R47 and R48 to obtain 90 to 100% modulation with a specified input signal.

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to FSK
SHIFT control to minimum
INT/EXT switch to EXT
FADING switch to OFF

(2) Adjust the SET CARRIER control to bring the meter pointer to the 0-dB mark on the scale.

(3) Insert an unconnected plug into the front-panel EXT MOD telephone-jack and adjust the ratio of resistors R47 and R48 so that the meter deflection falls to half that obtained in step (2).

4.9.13. (continued)

(4) Feed a 10-volt r.m.s., 50-c/s, signal from the b.f.o. (item 1) into the EXT. MOD. front-panel telephone-jack via the plug provided.

(5) Connect the output of the Telegraph Test Generator to the oscilloscope (Y plate) and observe the waveform.

(6) Make adjustments, if necessary, to the values of R47 and R48 to produce a waveform showing between 90 and 100% modulation depth with minimum distortion.

4.9.14. Measurement of Mark/Space Suppression

(Apparatus required: Items n and o)

To measure the relative level of the output signal during 'mark' and 'space' periods:-

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to ON-OFF (CW)
INT/EXT switch to MECH
FADING switch to OFF

(2) Connect the output of the Telegraph Test Generator to the input of the variable attenuator and the variable attenuator output to the input of the sensitivity receiver.

(3) Adjust the Telegraph Test Generator attenuator controls for maximum output and set the variable attenuator controls for 0 dB.

(4) Join the EXT. MECH. terminals as follows:-

T to M on CHANNEL A
No connection on CHANNEL B

(5) Tune the receiver to 3.1 Mc/s and adjust the gain control for a convenient reading on the receiver output meter.

(6) Reset the variable attenuator control for 70 dB and reconnect the EXT. MECH. terminals as follows:-

T to S on CHANNEL A
No connection on CHANNEL B

(7) Without altering the receiver gain control, adjust the variable attenuator to obtain the same reading on the receiver output meter as in (5).

4.9.14. (continued)

(8) Note the variable attenuator setting: this should be approximately 60 dB.

(9) Retune the Telegraph Test Generator and receiver to 6.2 Mc/s and repeat the measurement procedure. The mark/space suppression should be approximately 50 dB.

(10) Retune the Telegraph Test Generator and receiver to 9.3 Mc/s and repeat the measurement procedure. The mark/space suppression should be approximately 45 dB.

4.9.15. Measurement of Bias Distortion (Apparatus required: Items g and m)

Distortion due to either the marking or spacing elements being lengthened due to asymmetry in the Telegraph Test Generator circuits is measured by comparing the output waveform with the applied modulating signal.

(1) Set the front-panel controls as follows:-

FREQUENCY switch to 3.1 Mc/s
Keying Selector to ON-OFF (CW)
INT/EXT switch to EXT. ELEC
FADING switch to OFF

(2) Feed a 20-volt, 200-c/s, square wave signal from the video oscillator (item m) into the EXT. ELEC. A front-panel telephone-jack and to the oscilloscope (Y_1 plate).

(3) Connect the output from the Telegraph Test Generator to the oscilloscope (Y_2 plate).

(4) Compare the length of (a) the 'mark' elements of both waveforms and (b) the 'space' elements of both waveforms. The difference in length of (a) or (b) should not exceed ±5% of the modulating elements.

4.9.16. Measurement of Spurious Amplitude Modulation on FSK (Apparatus required: Item f)

The level of the amplitude modulation superimposed on the f.s.k. signal should not exceed 12%. This modulation takes the form of a variation in amplitude between the shifted and unshifted signal.

4.9.16. (continued)

(1) Set the front-panel controls as follows:-

FREQUENCY switch	to 3.1 Mc/s
Keying Selector	to FSK
INT/EXT switch	to INT. CH.A.
FADING switch	to OFF
SHIFT control	to 1,200 c/s.

(2) Connect the Telegraph Test Generator output to the oscilloscope (Y plate).

(3) Measure the amplitude modulation depth, M, from the c.r.o. display using the formula:-

$$M(\%) = \frac{D_{max} - D_{min}}{D_{max} + D_{min}} \times 100$$

where D_{max} = peak-to-peak dimension of the c.r.o. display

D_{min} = trough-to-trough dimension of the c.r.o. display

The modulation depth measured should not exceed 12%.

4.9.17. Measurement of Frequency Stability

(Apparatus required: Items b and e)

After a warm-up period of at least 30 minutes, the frequency stability of the r.f. oscillator should be measured as follows:-

(1) Set the front-panel controls as follows:-

FREQUENCY switch	to 3.1 Mc/s
Keying Selector	to ON-OFF (CW)
INT/EXT switch	to INT. CH.A
FADING switch	to OFF

(2) Insert an unwired telephone-plug into the EXT. MOD. front-panel jack so as to provide an uninterrupted c.w. output.

4.9.17. (continued)

(3) Connect the Power Unit to the mains supply via the Variac set to deliver an output voltage equal to that for which the mains transformer tapping panel is adjusted. Allow at least 30 minutes to elapse for the oscillator frequency to stabilize.

(4) Connect the output of the Telegraph Test Generator to the frequency meter and measure the oscillator frequency.

(5) Vary the mains input supply by ±10% by means of the Variac and measure the oscillator frequency. The frequency stability should be better than ±0.001% for ambient temperatures between 20°C and 50°C.

APPENDICES

VALVE REPLACEMENT DATA ..... VRD 1167

COMPONENT LAYOUT ILLUSTRATIONS
- Front Panels ..... MP 1167 - 1
- R.F. Unit-Top (with screening cover removed) ... MP 1167 - 2
- R.F. Unit-Bottom ..... MP 1167 - 3
- Interior of R.F. Box ..... MP 1167 - 4
- Power Unit Chassis - Top ..... MP 1167 - 5
- Power Unit Chassis - Bottom ..... MP 1167 - 6

SPARES ORDERING SCHEDULE WITH CIRCUIT REFERENCES SOS/1167

FUNCTIONAL DIAGRAM ..... TLC 27265

CIRCUIT DIAGRAM OF TELEGRAPH TEST GENERATOR ..... TLD 27788 (Sheet 1)

CIRCUIT DIAGRAM OF STABILIZED POWER UNIT .... TLC 27802 (Sheet 1)

DECIBEL CONVERSION TABLE ..... OM G-SUPP dB

AMENDMENT SHEET No. AM 637/1

Operating and Maintenance Handbook

for

TELEGRAPH TEST GENERATOR TYPE TF 1167

Mains Input Voltage Tapping Panel

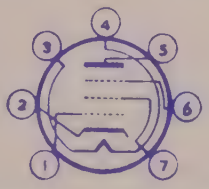
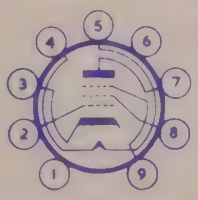
On some instruments, the mains input voltage tapping panel is different from that described in the handbook (pages 34 and 35), and there is no 150-volt tap. The alternative panel consists of a plug-link and socket system, and a series of diagrams showing the various plug settings for different voltages is shown on the accompanying SUPPLY VOLTAGE PLUG SETTINGS sheet. The sheet is self-explanatory.

VALVE REPLACEMENT DATA

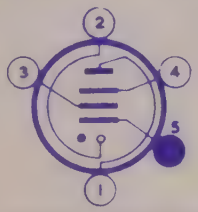
FOR

TELEGRAPH TEST GENERATOR Type TF 1167

Any valve which becomes faulty should preferably be replaced by a valve of the type originally supplied in the instrument and designated in the following table. If this is not possible, the additional data given by the table may be used as a guide to suitable alternatives.

Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V1, V3 PENTODE MARCONI Z77	EF91 6AM6 6F12 8D3	CV138	MINIATURE 7-PIN (B7G) 	
V2, V5, V6, V10, V12 DOUBLE TRIODE BRIMAR 12AT7	ECC81	CV455	MINIATURE 9-PIN (B9A) 	12AT7
V4 PENTODE BRIMAR 6CH6	EL821 7D10	CV2127	MINIATURE 9-PIN (B9A) 	6CH6

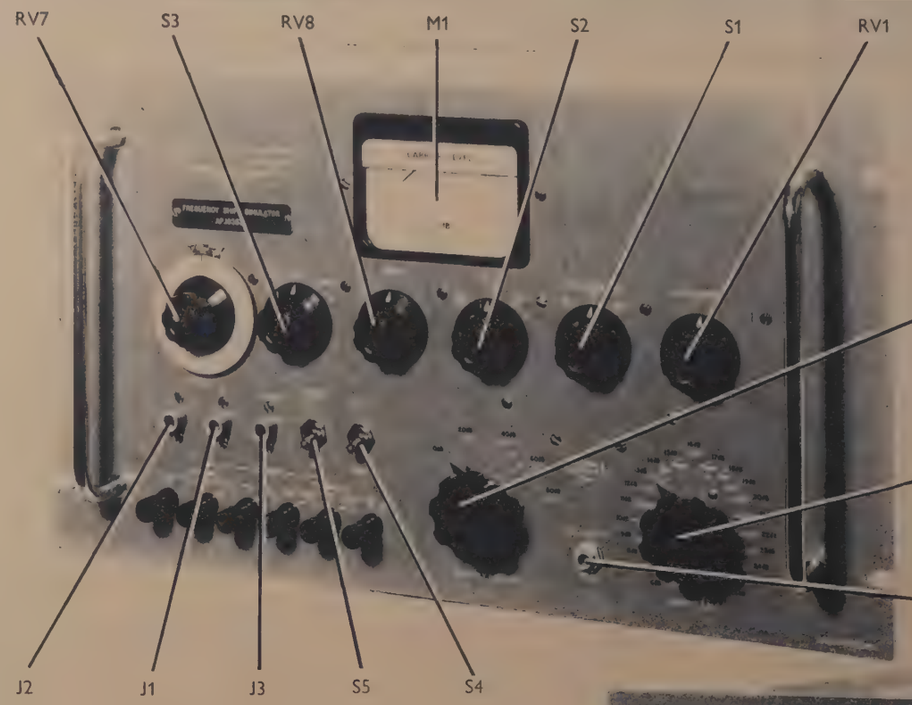
12 JAN 1965
MARCONI
INST. LTD.

Valve	*British Commercial Equivalent*	*British Services Equivalent*	*Base*	*U.S. Equivalent*
V7, V8, V9, V11 DOUBLE DIODE MARCONI D77	6AL5 6D2 D152 DD6 EB91	CV140	MINIATURE 7-PIN (B7G) 	6AL5
V1, V2 Power Unit STABILIZER MARCONI STV280/80		CV1069	BRITISH 5-PIN (B5)  	

12 JAN 1965
MARCONI
INST. LTD.

FRONT PANELS

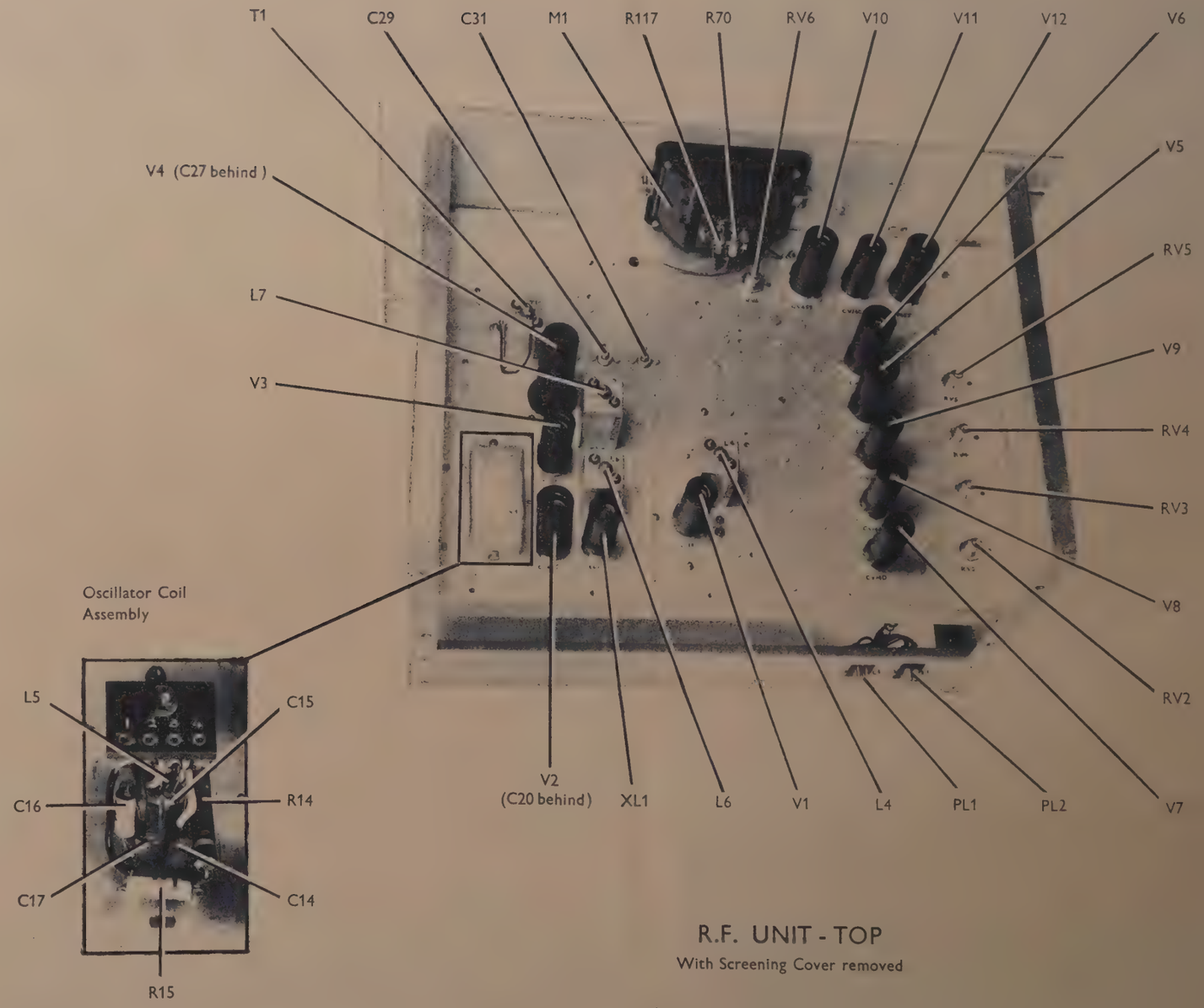
MARCONI INSTRUMENTS LIMITED							
DRN	D. H.	DATE	2 58	CHKD	G. R. G.	ISSUE	1
STOCK LIST	TF 1167			DRG No.	MP 1167 - 1		



FRONT PANELS

R.F. UNIT

TOP



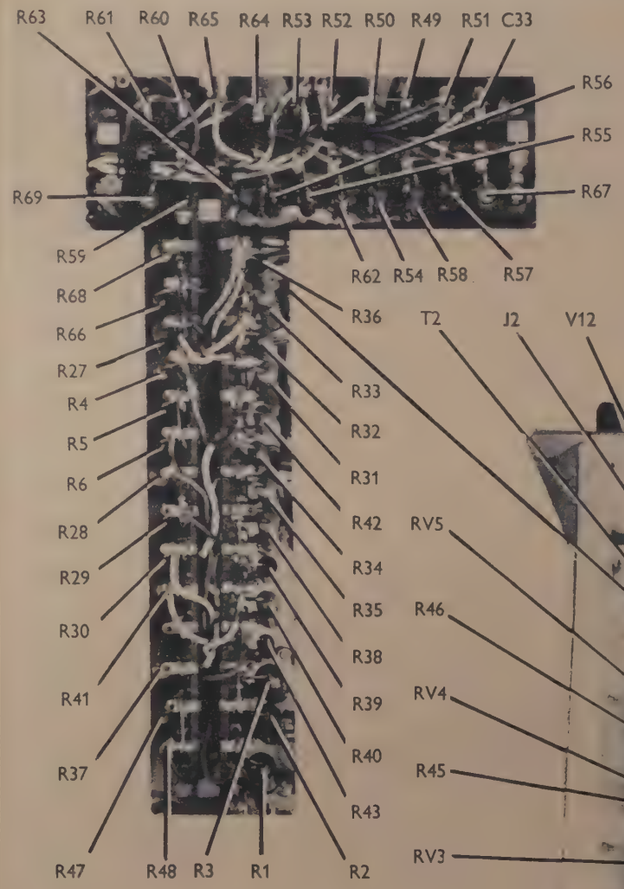
R.F. UNIT - TOP

With Screening Cover removed

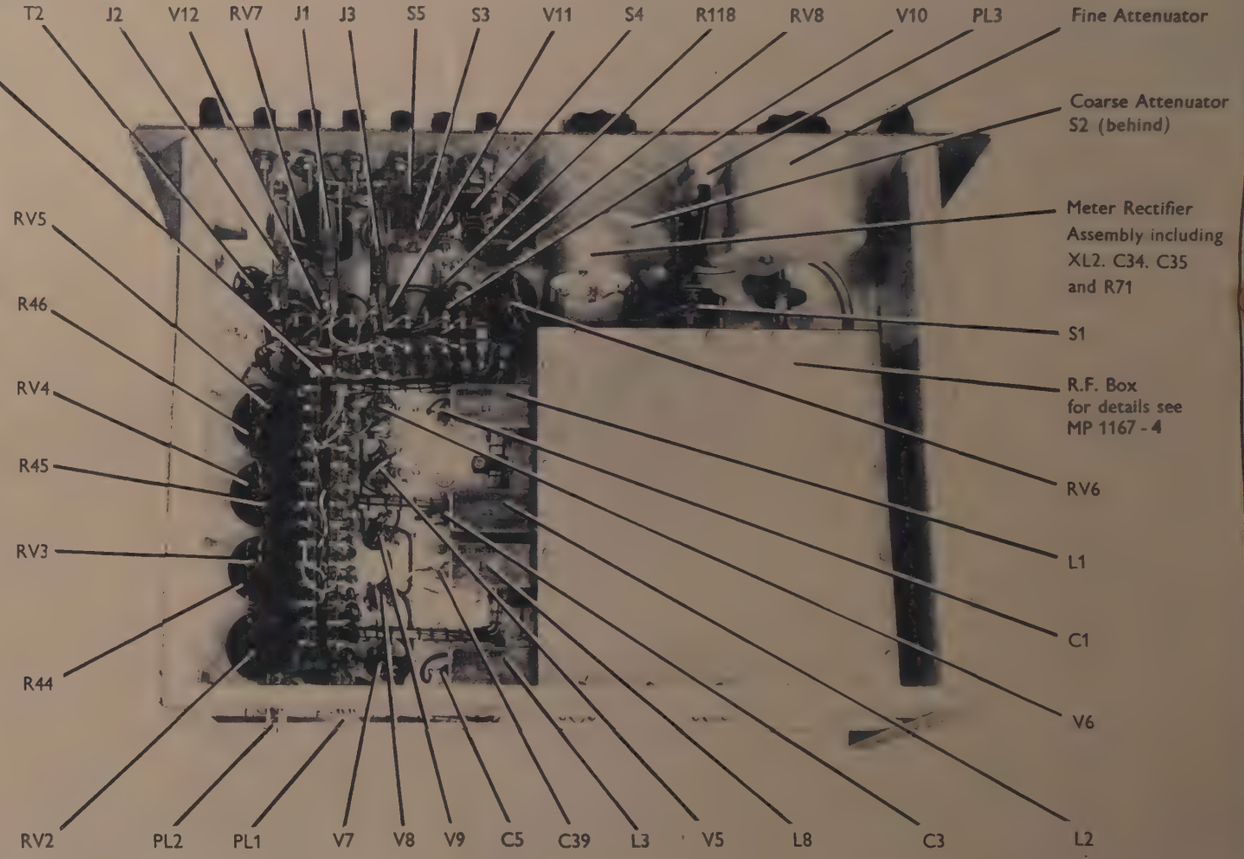
MARCONI INSTRUMENTS LIMITED							
DRN	D. H.	DATE	2 58	CHKD	G. R. G.	ISSUE	1
STOCK LIST	TF 1167			DRG No.	MP 1167 - 2		

R.F. UNIT

BOTTOM



Close-up of Tag Panel



Fine Attenuator

Coarse Attenuator S2 (behind)

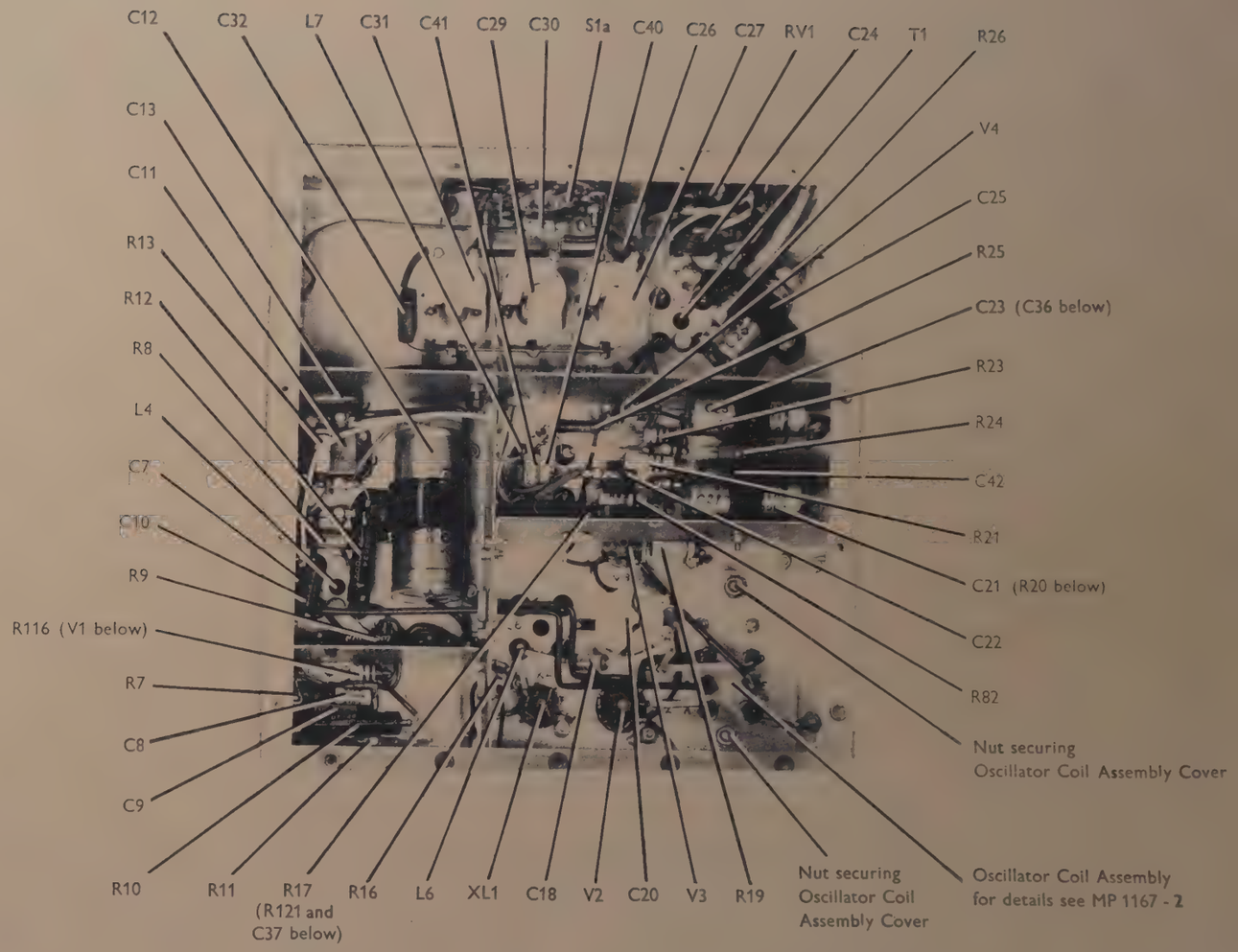
Meter Rectifier Assembly including XL2. C34. C35 and R71

R.F. Box for details see MP 1167 - 4

R.F. UNIT
BOTTOM

MARCONI INSTRUMENTS LIMITED							
DRN	D. H.	DATE	2 58	CHKD	G. R. G.	ISSUE	1
STOCK LIST	TF 1167			DRG No.	MP 1167 - 3		

INTERIOR OF R.F. BOX

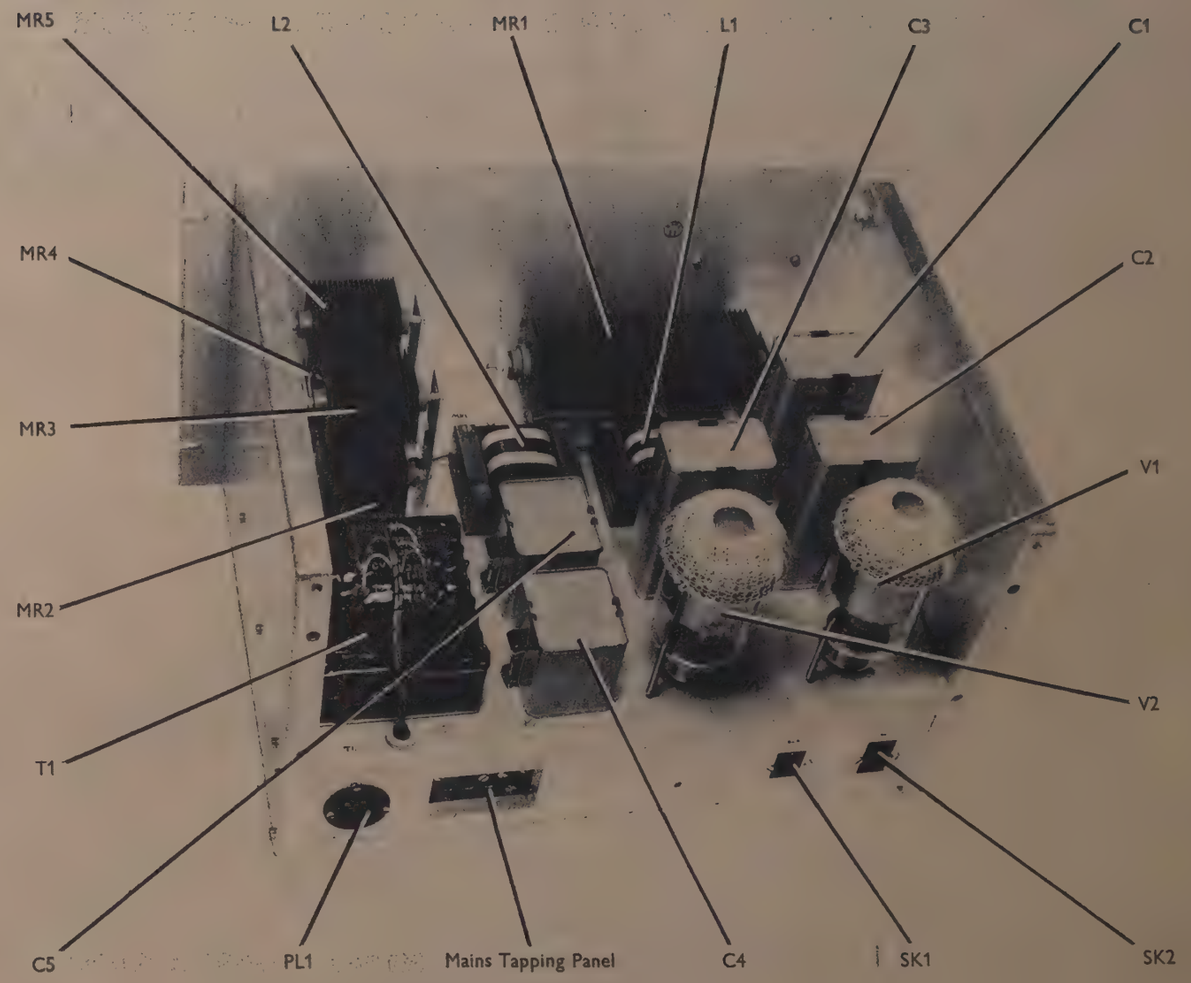


INTERIOR OF R.F. BOX

MARCONI INSTRUMENTS LIMITED							
DRN	D H.	DATE	2 58	CHKD	G. R. G.	ISSUE	2
STOCK LIST	TF 1167			DRG No.	MP 1167 - 4		

POWER UNIT CHASSIS

TOP



POWER UNIT CHASSIS

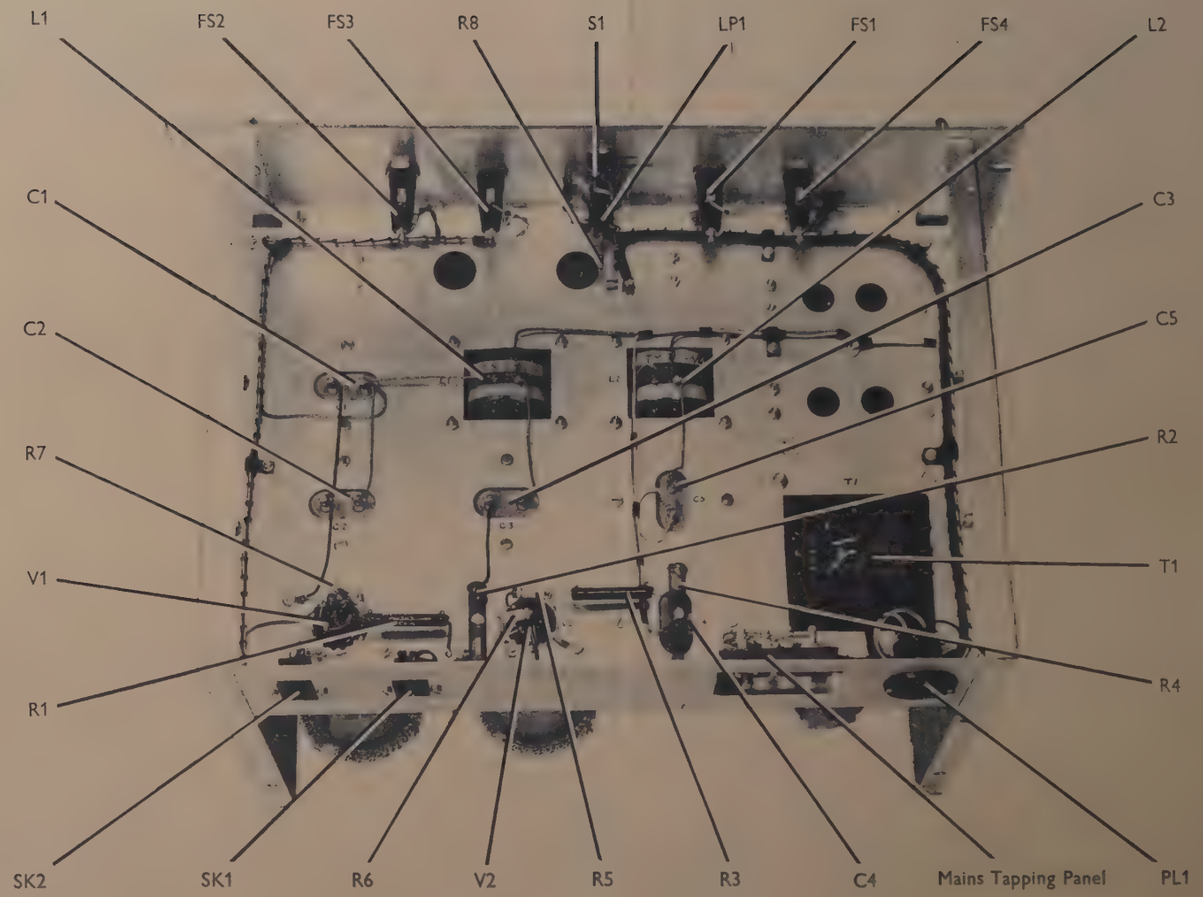
TOP

MP 1167 - 5

MARCONI INSTRUMENTS LIMITED							
DRN	D. H.	DATE	2/58	CHKD	G. R. G.	ISSUE	1
STOCK LIST	TF 1167			DRG No.	MP 1167 - 5		

POWER UNIT CHASSIS

BOTTOM



POWER UNIT CHASSIS

BOTTOM

MARCONI INSTRUMENTS LIMITED							
DRN	D. H.	DATE	2 58	CHKD	G. R. G.	ISSUE	1
STOCK LIST	TF 1167			DRG No.	MP 1167 - 6		

SPARES ORDERING SCHEDULE No. SOS/1167

WITH CIRCUIT REFERENCES

for

TELEGRAPH TEST GENERATOR TYPE TF 1167

Applicable to Instruments Serial Nos:-

513301 to 513330
JG 53/01 to JG 53/25
JG 393/01 to JG 393/25
JG 831/01 to JG 831/25
JG 637/01 to JG 637/25

When ordering replacement parts, ALWAYS QUOTE THE TYPE NUMBER AND SERIAL NUMBER OF THE INSTRUMENT CONCERNED.

To specify the individual parts required, STATE FOR EACH PART THE QUANTITY REQUIRED AND THE APPROPRIATE SOS ITEM NUMBER.

For example, to order replacements for the 100-kΩ resistor, R7, and the 200-μμF capacitor, C7, in Part 1, quote as follows:-

Spares for TF 1167, Serial No. 000000

1 off, SOS Item 5
1 off, SOS Item 134

It is important that the distinguishing code "SOS" preceding each item number should not be omitted.

SOS Item No.	Circuit Ref.	Description	Works Ref.
		PART 1: For use with R.F. Unit, Circuit Diagram No. TLD 27788	
R.F. UNIT		RESISTORS	
1	R1	Composition, 100 kΩ ±5%, 1W.	PC66607/49
2	R2	Composition, 8.2 kΩ ±5%, 1W.	PC66607/36

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
3	R3	Composition, 4.7 kΩ ±5%, 1W.	PC66607/33
4	R4	Composition, 1 MΩ*, ½W.	PC66605/61
5	R5	Composition, 330 kΩ*, ½W.	PC66605/55
6	R6	Composition, 680 kΩ*, ½W.	PC66605/59
7	R7	Composition, 100 kΩ ±5%, ½W.	PC66605/49
8	R8	Composition, 1 MΩ ±10%, 3/4W.	PC66612/55
9	R9	Wirewound, 22 kΩ ±5%, 6W.	PC67010/21
10	R10	Composition, 1.8 kΩ ±5%, 1W.	PC66607/28
11	R11	Composition, 2.2 kΩ ±5%, 1W.	PC66607/29
12	R12	Composition, 220 kΩ ±5%, 1W.	PC66607/53
13	R13	Composition, 10 kΩ ±10%, ½W.	PC66611/37
14	R14	Composition, 100 kΩ ±10%, 3/4W.	PC66612/43
15	R15	Composition, 47 kΩ ±10%, ½W.	PC66611/45
16	R16	Composition, 10 kΩ ±10%, ½W.	PC66611/37
17	R17	Composition, 330 kΩ ±10%, 3/4W.	PC66612/49
18	R19	Composition, 220 kΩ ±10%, ½W.	PC66611/53
19	R20	Composition, 330 Ω ±10%, ½W.	PC66611/19
20	R21	Composition, 4.7 kΩ ±10%, ½W.	PC66611/33
21	R22	Composition, 3.3 kΩ ±10%, 3/4W.	PC66612/25
22	R23	Composition, 100 Ω ±10%, 1/4W.	PC66610/13

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
23	R24	Composition, 100 kΩ ±10%, 1/4W.	PC66609/43
24	R25	Composition, 150 Ω ±5%, ½W.	PC66605/15
25	R26	Composition, 4.7 kΩ ±5%, .6W.	PC67010/17
26	R27	Composition, 47 kΩ* ±10%, ½W.	PC66611/45
27	R28	Composition, 1 MΩ ±10%, 3/4W.	PC66612/55
28	R29	Composition, 47 kΩ ±10%, 1W.	PC66615/45
29	R30	Composition, 47 kΩ ±10%, 1W.	PC66615/45
30	R31	Composition, 1 MΩ ±10%, 3/4W.	PC66612/55
31	R32	Composition, 330 kΩ ±10%, ½W.	PC66611/55
32	R33	Composition, 1 MΩ ±10%, 3/4W.	PC66612/55
33	R34	Composition, 2.2 MΩ ±10%, ½W.	PC66611/65
34	R35	Composition, 1.5 MΩ ±10%, 3/4W.	PC66612/57
35	R36	Composition, 47 kΩ ±10%, 1W.	PC66615/45
36	R37	Composition, 22 kΩ ±10%, 3/4W.	PC66612/35
37	R38	Composition, 2.2 kΩ ±10%, 3/4W.	PC66612/23
38	R39	Composition, 47 kΩ ±10%, 1W.	PC66615/45
39	R40	Composition, 1.5 MΩ ±10%, 3/4W.	PC66612/57
40	R41	Composition, 470 kΩ ±10%, ½W.	PC66611/57
41	R42	Composition, 470 kΩ ±10%, ½W.	PC66611/57
42	R43	Composition, 6.8 kΩ* ±5%, ½W.	PC66605/35

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
43	R44	Composition, 330 Ω ±5%, ½W.	PC66605/19
44	R45	Composition, 330 Ω ±5%, ½W.	PC66605/19
45	R46	Composition, 330 Ω ±5%, ½W.	PC66605/19
46	R47	Composition, 56 kΩ* ±10%, ½W.	PC66611/46
47	R48	Composition, 270 kΩ*, ½W.	PC66611/54
48	R49	Composition, 1.5 kΩ ±10%, ½W.	PC66611/27
49	R50	Composition, 47 kΩ ±10%, 1W.	PC66615/45
50	R51	Composition, 68 kΩ ±10%, ½W.	PC66611/47
51	R52	Composition, 1.5 MΩ ±5%, 3/4W.	PC66606/65
52	R53	Composition, 820 kΩ ±5%, ½W.	PC66605/60
53	R54	Composition, 2.2 MΩ ±10%, ½W.	PC66611/65
55a	R55	Composition, 10 kΩ ±5%, 1/4 W.	58/MX2154A
56	R57	Composition, 1 MΩ ±5%, ½W.	PC66605/61
57	R58	Composition, 1 MΩ ±5%, ½W.	PC66605/61
58	R59	Composition, 47 kΩ ±5%, ½W.	PC66605/45
59	R60	Composition, 470 kΩ ±5%, 3/4W.	PC66606/57
60	R61	Composition, 470 kΩ ±5%, 3/4W	PC66606/57
61	R62	Composition, 1.5 kΩ ±5%, ½W.	PC66605/27
62	R63	Composition, 47 kΩ ±5%, ½W.	PC66605/45

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
63	R64	Composition, 100 kΩ ±5%, 3/4W.	PC66606/49
64	R65	Composition, 100 kΩ ±5%, 3/4W.	PC66606/49
65	R66	Composition, 330 Ω ±5%, ½W.	PC66605/19
66	R67	Composition, 100 kΩ ±10%, 3/4W.	PC66612/43
67	R68	Composition, 1 MΩ ±10%, 3/4W.	PC66612/45
68	R69	Composition, 1 MΩ ±10%, 3/4W.	PC66612/45
69	R70	Composition, 10 kΩ ±10%, ½W.	PC66611/37
70	R71	Composition, 1.5 kΩ ±20%, 1/8W.	5-MX2154A/8
71	R72	Carbon High Stability, 220 Ω ±1%, 1/8W.	38-TM4297
72	R73	Carbon High Stability, 82.5 Ω ±1%, 1/8W.	36-TM4297
73	R74	Carbon High Stability, 742 Ω ±1%, 1/8W.	35-TM4297
74	R75	Carbon High Stability, 742 Ω ±1%, 1/8W.	35-TM4297
75	R76	Carbon High Stability, 742 Ω ±1%, 1/8W.	35-TM4297
76	R77	Carbon High Stability, 742 Ω ±1%, 1/8W.	35-TM4297
77	R78	Carbon High Stability, 91.6 Ω ±1%, 1/8W.	37-TM4297
78	R79	Carbon High Stability, 91.6 Ω ±1%, 1/8W.	37-TM4297
79	R80	Carbon High Stability, 91.6 Ω ±1%, 1/8W.	37-TM4297
80	R81	Carbon High Stability, 82.5 Ω ±1%, 1/8W.	36-TM4297
81	R82	Composition, 47 kΩ ±10%, ½W.	PC66611/45
82	R83	Carbon High Stability, 122 Ω ±1%, 1/4W.	SD/B99028-P90975

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
83	R84	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
84	R85	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
85	R86	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
86	R87	Carbon High Stability, 387 Ω ±1%, 1/4W.	SD/B99027-P90975
87	R88	Carbon High Stability, 17.9 Ω ±5%, 1/4W.	SD/B99030-P90975
88	R89	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
89	R90	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
90	R91	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
91	R92	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
92	R93	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
93	R94	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
94	R95	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
95	R96	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
96	R97	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
97	R98	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
98	R99	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
99	R100	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
100	R101	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
101	R102	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
102	R103	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		RESISTORS (continued)	
103	R104	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
104	R105	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
105	R106	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
106	R107	Carbon High Stability, 35.75 Ω ±5%, 1/4W.	SD/B99029-P90975
107	R108	Carbon High Stability, 370 Ω ±1%, 1/4W.	SD/B99032-P90975
108	R109	Carbon High Stability, 122 Ω ±1%, 1/4W.	SD/B99028-P90975
109	R110	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
110	R111	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
111	R112	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
112	R113	Carbon High Stability, 332 Ω ±1%, 1/4W.	SD/B99025-P90975
113	R114	Carbon High Stability, 3370 Ω ±1%, 1/4W.	SD/B99026-P90975
114	R115	Carbon High Stability, 100 Ω ±1%, 1/4W.	SD/B99031-P90975
115	R116	Composition, 100 Ω ±10%, 1/4W.	PC66610/13
116	R117	Composition, 390 Ω*, ½W.	PC66611/20
117	R118	Composition, 820 Ω*, 1/4W.	PC66610/24
118	R121	Composition, 47 kΩ ±10%, ½W.	PC66611/45
119	R122	Composition, 1 MΩ ±10%, ½W.	PC66611/61

* Nominal value; actual value determined during calibration.

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		VARIABLE RESISTORS	
120	RV1	Wirewound, 100 kΩ ±10%, 1W Linear.	PC67402/55
121	RV2	Carbon, 500 Ω ±20%, 3/4W Linear.	47-MX2154A
122	RV3	Carbon, 500 Ω ±20%, 3/4W Linear.	47-MX2154A
123	RV4	Carbon, 500 Ω ±20%, 3/4W Linear.	47-MX2154A
124	RV5	Carbon, 500 Ω ±20%, 3/4W Linear.	47-MX2154A
125	RV6	Composition, 50 kΩ ±20%, 3/4W Linear.	PC67203/21
126	RV7	Composition, 100 kΩ ±20%, 3/4W Linear.	PC67203/27
127	RV8	Wirewound, 100 kΩ ±10%, 1W Linear.	PC67402/54
		CAPACITORS	
128	C1	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
129	C2	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
130	C3	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
131	C4	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
132	C5	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
133	C6	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
134	C7	Mica, 200 μμF ±5%, 350 V d.c.	51-MX2154A
135	C8	Ceramic, 22 μμF ±10%, 500 V d.c.	PC18202/5
136	C9	Mica, 2000 μμF ±10%, 350 V d.c.	53-MX2154A

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		CAPACITORS (continued)	
137	C10	Mica, 200 μμF ±5%, 350 V d.c.	51-MX2154A
138	C11	Mica, 2000 μμF ±10%, 350 V d.c.	53-MX2154A
139	C12	Paper, 1.0 μF ±20%, 350 V d.c.	PC19202/21
140	C13	Mica, 2000 μμF ±10%, 350 V d.c.	53-MX2154A
141	C14	Mica, 500 μμF ±2%, 350 V d.c.	55-MX2154A
142	C15	Ceramic, 100 μμF ±10%, 500 V d.c.	PC18202/13
143	C16	Ceramic, 33 μμF ±10%, 500 V d.c.	PC18202/7
144	C17	Mica, 1000 μμF ±5%, 350 V d.c.	57-MX2154A
145	C18	Ceramic, 22 μμF ±10%, 500 V d.c.	PC18202/5
146			
147	C20	Variable, Air Spaced, 4-16 μμF.	PC20002/4
148	C21	Paper, 1 μF ±50% -20%, 350 V d.c.	77-MX2154A
149	C22	Mica, 50 μμF ±2%, 350 V d.c.	61-MX2154A
150	C23	Paper, 0.1 μF ±20%, 350 V d.c.	PC19202/15
151	C24	Mica, 2000 μμF ±10%, 350 V d.c.	53-MX2154A
152	C25	Paper, 0.1 μF ±20%, 350 V d.c.	PC19202/15
153	C26	Mica, 1000 μμF ±5%, 350 V d.c.	57-MX2154A
154	C27	Variable, Air Spaced, 4.8-95 μμF.	PC20002/7
155	C28	Variable, Air Spaced, 4.8-95 μμF.	PC20002/7
156	C30	Ceramic, 47 μμF ±10%, 500 V d.c.	PC18202/9

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		CAPACITORS (continued)	
157	C31	Variable, Air Spaced, 4.8-95 μμF.	PC20002/7
158	C32	Mica, 470 μμF*±10%, 350 V d.c.	67-MX2154A
159	C33	Paper, 0.05 μF ±20%, 350 V d.c.	PC19202/13
160	C34	Ceramic, 0.001 μF ±20%, 400 V d.c.	39-TM4297
161	C35	Paper, 0.001 μF ±20%, 400 V d.c.	46-TM4297
162	C36	Paper, 0.05 μF ±20%, 350 V d.c.	PC19202/13
163	C37	Ceramic, 4.7 μμF ±10%, 500 V d.c.	PC18201/5
164	C38	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
165	C39	Feed Through, 4700 μμF, 500 V d.c.	191-MX2154A
166	C40	Ceramic, 100 μμF ±10%, 500 V d.c.	PC18202/13
167	C41	Ceramic, 47 μμF ±10%, 500 V d.c.	PC18202/9
168	C42	Paper, 0.05 μF ±25%. 250 V d.c.	PC19302/1
168/2a	C44	Electrolytic, 16μF + 100 -20%, 200 V d.c.	121 - MX2154A
		INDUCTORS AND TRANSFORMERS	
169	L1	Filter Inductor.	194-MX2154A
170	L2	Filter Inductor.	194-MX2154A
171	L3	Filter Inductor.	194-MX2154A
172	L4	Variable Inductor, 360-700 μH.	173-MX2154A
173	L5	Oscillator Inductor, 39 μH.	167-MX2154A

* Nominal value; actual value determined during calibration

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		INDUCTORS AND TRANSFORMERS (continued)	
174	L6	Variable Inductor, 29-55 μH.	174-MX2154A
175	L7	Variable Inductor, 18.5-25 μH.	175-MX2154A
176	L8	Filter Inductor.	194-MX2154A
177	T1	Output Transformer.	176-MX2154A
178	T2	L.F. Transformer.	83-MX2154A
		SWITCHES	
179	S1	Rotary, 3 pole, 3 position, 2 wafer.	112-MX2154A
180	S2	Rotary, 3 pole, 3 position, 2 wafer.	113-MX2154A
181	S3	Rotary, 1 pole, 3 position, 1 wafer.	114-MX2154A
182	S4	Code 1/Code 2 Switch, D.P.C.O.	TB23903/2
183	S5	FADING ON-OFF Switch D.P.C.O.	TB23903/2
		PLUGS, SOCKETS AND TERMINALS	
184	J1	EXT. ELEC. B Jack.	106-MX2154A
185	J2	EXT. ELEC. A Jack.	106-MX2154A
186	J3	EXT. MOD. Jack.	107-MX2154A
187	PL1	Plug, 6-way.	92-MX2154A

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.) PLUGS, SOCKETS AND TERMINALS (continued)			
188	PL2	Plug, 8-way.	90-MX2154A
189	PL3	R.F. Output Plug, Coaxial, fixed, 75-ohm.	118-MX2154A
190		Coaxial Free Socket, to fit R.F. Output Plug.	119-MX2154A
191		Telephone Plug, to fit J1, J2, or J3.	108-MX2154A
192	M,T, or S.	Terminal, for EXT. MECH, Channel A or Channel B.	116-MX2154A
192/1	SK1	Coaxial Fixed Socket, 75-ohm	96-MX2154A
192/2	PL4	Coaxial Plug, Free, 75-ohm	7-MX2154A/8
		METER	
193		CARRIER LEVEL Meter, 200 μA, 500 Ω Nominal, moving coil.	103-MX2154A
		CRYSTALS, HOLDERS, AND RETAINERS	
194	XL1	Oscillator Crystal, 3.1 Mc/s.	69-MX2154A
195		Holder, for XL1.	PC81811/1
196		Retainer, for XL1.	PC17501/2
197	XL2	Germanium Diode, CV425 (CG1-E).	3-MX2154A/8
197/1	MR1	Zener Diode, ZB18	89-MX2154A
197/2	MR2	Zener Diode, ZB18	89-MX2154A

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT (Contd.) VALVES, HOLDERS AND RETAINERS			
198	V1	CV138 (Z77), Pentode.	70-MX2154A
199		Holder for V1.	PC81811/1
200		Retainer for V1.	PC17501/2
201	V2	CV455 (12AT7), Double Triode.	71-MX2154A
202		Holder for V2.	PC81816/1
203		Retainer for V2.	PC17502/2
204	V3	CV138 (Z77), Pentode.	70-MX2154A
205		Holder for V3.	PC81811/1
206		Retainer for V3.	PC17501/2
207	V4	CV2127 (6CH6), Pentode.	72-MX2154A
208		Holder and Retainer for V4, special heat dissipating.	81-MX2154A
209	V5	CV455 (12AT7), Double Triode.	71-MX2154A
210		Holder for V5.	PC81816/1
211		Retainer for V5.	PC17502/2
212	V6	CV455 (12AT7), Double Triode.	71-MX2154A
213		Holder for V6	PC81816/1
214		Retainer for V6	PC17502/2
215	V7	CV140 (6AL5), Double Diode.	73-MX2154A
216		Holder for V7.	PC81811/1
217		Retainer for V7.	PC17501/2

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.) VALVES, HOLDERS AND RETAINERS (continued)			
218	V8	CV140 (6AL5), Double Diode.	73-MX2154A
219		Holder for V8.	PC81811/1
220		Retainer for V8.	PC17501/2
221	V9	CV140 (6AL5), Double Diode.	73-MX2154A
222		Holder for V9.	PC81811/1
223		Retainer for V9.	PC17501/2
224	V10	CV455 (12AT7), Double Triode.	71-MX2154A
225		Holder for V10.	PC81816/1
226		Retainer for V10.	PC17502/2
227	V11	CV140 (6AL5), Double Diode.	73-MX2154A
228		Holder for V11.	PC81811/1
229		Retainer for V11.	PC17501/2
230	V12	CV455 (12AT7), Double Triode.	71-MX2154A
231		Holder for V12.	PC81816/1
232		Retainer for V12.	PC17502/2
		KNOBS, DRIVES AND DIALS	
233		Knob, skirted, for S1, S2, S3, RV1, or RV8.	TB17848
234		Knob, skirted, for RV7.	TB17848/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
R.F. UNIT(Contd.)		KNOBS, DRIVES AND DIALS (continued)	
235		Dial, uncalibrated, for SHIFT control, RV7.	128-MX2154A
236		Boss, to fit behind dial.	TB26856/1
237		Flexible coupling, to fit RV1 or S1.	TM2389
238		Cursor, for SHIFT dial.	TB25273/10
239		Knob, plain, for Coarse or Fine Attenuator.	TB23920/31
240		Pointer, for Coarse or Fine Attenuator.	TA3986/4
		MISCELLANEOUS	
241		Front Panel.	100-MX2154A
242		Front Panel Handles, Set of two.	TB13370/14
243		Dust Cover.	136-MX2154A
244		Screening Cover, perforated, to fit top of chassis.	141-MX2154A
245		Base Plate, for R.F. Box.	148-MX2154A
246		Screening Can, for L1, L2, L3, or L8.	TD25531/2
247		Screening Can, for L4, L6, L7, or T1.	TB15122
248		Screening Can, for L5, complete with eye bolts.	TA5744 155-MX2154A
249		Lock Nut, for RV2, RV3, RV4, RV5, or RV6.	TB24000/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
		PART 2: For use with Power Unit, Circuit Diagram No. TLC27802	
POWER UNIT		RESISTORS	
250a	R1	Wirewound, 5 kΩ ±5% 6W.	1-MX2154A/1
251	R2	Composition, 220 kΩ ±10%, 2W.	PC66616/53
252a	R3	Wirewound, 4.7 kΩ ±10%, 6W.	3-MX2154A
253	R4	Composition, 220 kΩ ±10%, 2W.	PC66616/53
254	R5	Composition, 220 kΩ ±10%, ½W.	PC66611/53
255	R6	Composition, 220 kΩ ±10%, ½W.	PC66611/53
256	R7	Composition, 220 kΩ ±10%, ½W.	PC66611/53
257	R8	Composition, 10 Ω ±10%, ½W.	PC66611/1
257/1	R9	4.7 kΩ ±10% 6W. Wirewound.	3-MX2154A/1
		CAPACITORS	
258	C1	Paper, 8 μF ±20%, 600 V d.c.	PC19212/4
259	C2	Paper, 8 μF ±20%, 600 V d.c.	PC19212/4
260	C3	Paper, 8 μF ±20%, 600 V d.c.	PC19212/4
261	C4	Paper, 4 μF ±20%, 600 V d.c.	PC19212/3
262	C5	Paper, 4 μF ±20%, 600 V d.c.	PC19212/3

SOS Item No.	Circuit Ref.	Description	Works Ref.
POWER UNIT (Contd.)		CHOKES	
263	L1	Smoothing Choke, 8H, 100 mA.	38-MX2154A/1
264	L2	Smoothing Choke, 8H, 100 mA.	38-MX2154A/1
		TRANSFORMER	
265	T1	Mains Transformer.	37-MX2154A/1
		METAL RECTIFIERS	
266	MR1	H.T. Rectifier, 4A232.	10-MX2154A/1
267	MR2	H.T. Rectifier, 5B88.	11-MX2154A/1
268	MR3	H.T. Rectifier, 5B88.	11-MX2154A/1
269	MR4	H.T. Rectifier, 5B88.	11-MX2154A/1
270	MR5	H.T. Rectifier, 5B88.	11-MX2154A/1
		VALVES, HOLDERS, AND RETAINERS	
271	V1	CV1069 (STV 280/80), Voltage Stabilizer.	13-MX2154A/1
272		Holder for V1.	PC81805/1
273		Retainer for V1.	15-MX2154A/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
POWER UNIT (Contd.) VALVES, HOLDERS AND RETAINERS (continued)			
274	V2	CV1069 (STV 280/80), Voltage Stabilizer.	13-MX2154A/1
275		Holder for V2.	PC81805/1
276		Retainer for V2.	15-MX2154A/1
		FUSES AND FUSE HOLDERS	
277	FS1	Mains Fuse, glass cartridge, 2-amp.	28-MX2154A/1
278		Holder for FS1.	26-MX2154A/1
279	FS2	H.T. Fuse, glass cartridge, 250-mA.	29-MX2154A/1
280		Holder for FS2.	26-MX2154A/1
281	FS3	H.T. Fuse, glass cartridge, 250-mA.	29-MX2154A/1
282		Holder, for FS3.	26-MX2154A/1
283	FS4	L.T. Fuse, glass cartridge, 15-amp.	27-MX2154A/1
284		Holder, for FS4.	26-MX2154A/1
		LAMP AND HOLDER	
285	LP1	Pilot Lamp, 6.3-volt, 0.15-amp.	19-MX2154A/1
286		Holder, for LP1, with red lens.	TB25073/1

SOS Item No.	Circuit Ref.	Description	Works Ref.
POWER UNIT (Contd.)		SWITCH	
287	SW1	MAINS Switch, D.P.C.O.	TB23903/2
		PLUGS, SOCKETS AND CONNECTING LEADS	
288	PL1	Mains Input Plug, 3-pin, 3-amp.	25-MX2154A/1
289	SK1	Socket, fixed, 6-way.	32-MX2154A/1
290	SK2	Socket, fixed, 8-way.	30-MX2154A/1
291		Inter-unit Connecting Lead, 3-ft long, complete with 8-way plug, Item 292, and 8-way socket, Item 293.	85-MX2154A
292		Free Plug, 8-way, included in Item 291.	94-MX2154A
293		Free socket, 8-way, included in Item 291.	91-MX2154A
294		Inter-Unit Connecting Lead, 3-ft long, complete with 6-way plug, Item 295 and 6-way socket, Item 296.	86-MX2154A
295		Free Plug, 6-way, included in Item 294.	95-MX2154A
296		Free Socket, 6-way, included in Item 294.	93-MX2154A
297		Mains Lead, 6 ft 6 in. long, with 3-pin plug, Item 298, and 3-pin socket, Item 299.	TM2560/AR
298		Plug, 3-pin, 5-amp, included in Item 297.	3-TM2560/AR
299		Socket, 3-pin, included in Item 297.	1-TM2560/AR
300		Grommet Sleeve, included in Item 297.	4-TM2560/AR

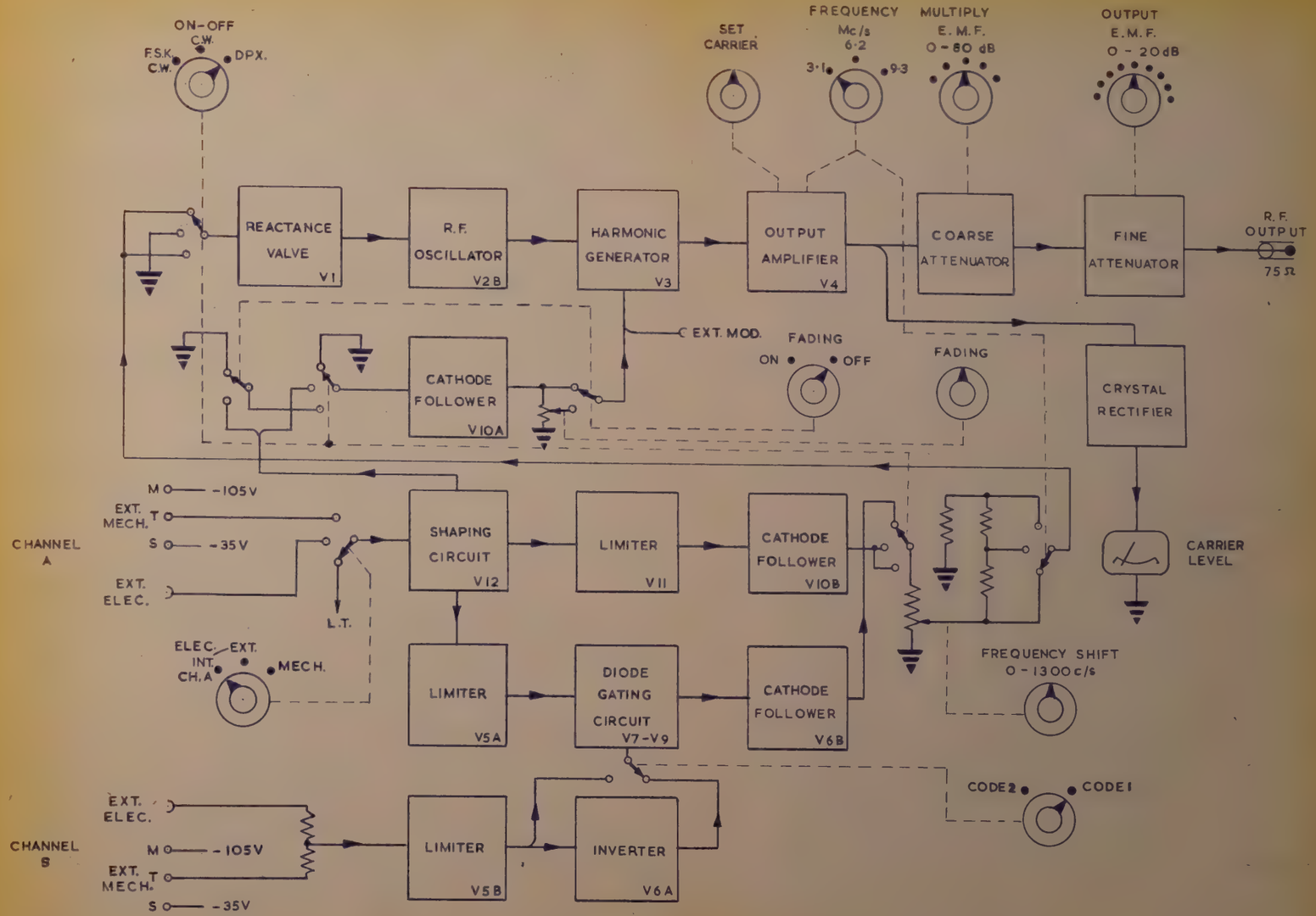
SCS Item No.	Circuit Ref.	Description	Works Ref.
POWER UNIT (Contd.)		MISCELLANEOUS	
301		Front Panel.	46-MX2154A/1
302		Front Panel Handles, Set of two.	TB13370/14
303		Dust Cover.	61-MX2154A/1
304		Clamps for capacitor C1 or C2, Set of two.	34-MX2154A/1
305		Clamps for capacitors C3, C4, or C5, Set of two.	35-MX2154A/1
		GENERAL	
306		Operating and Maintenance Handbook. (for complete equipment)	OM 1167

BLOCK SCHEMATIC DIAGRAM

OF

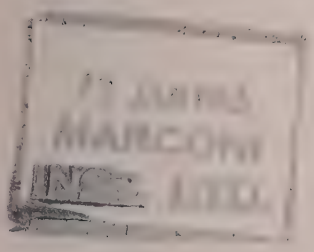
TELEGRAPH TEST GENERATOR

TYPE TF1167



BLOCK SCHEMATIC DIAGRAM OF TELEGRAPH TEST GENERATOR TYPE TF1167

MARCONI INSTRUMENTS LIMITED							
DRN	G. R. G.	DATE	28-1-58	CHKD		ISSUE	1
STOCK LIST	TF1167			DRG NO	TLC 27265		

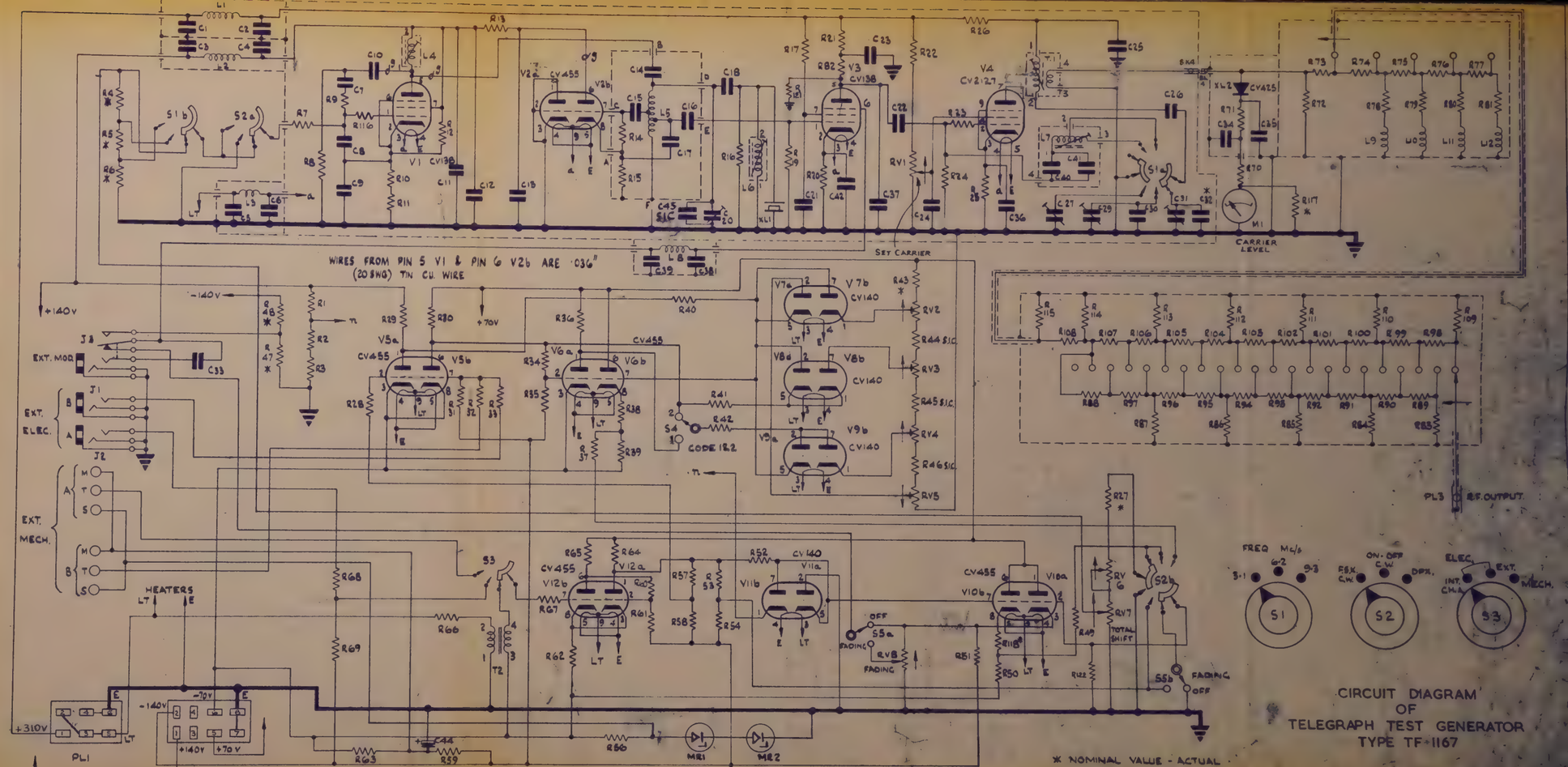

MARCONI

CIRCUIT DIAGRAM

OF

TELEGRAPH TEST GENERATOR

TYPE TF 1167



* NOMINAL VALUE - ACTUAL VALUE DETERMINED DURING CALIBRATION

CIRCUIT DIAGRAM
OF
TELEGRAPH TEST GENERATOR
TYPE TF-1167

TLD 27788 SHEET 1 OF 2 SHEETS

MARCONI INSTRUMENTS LIMITED.						
M.C.	DATE	23-1-58	CHKD.	JKW.	ISSUE	15
LIST	TF 1167		DRG. No.	TLD 27788		

12 JAN 1965
MARCONI
INST. LTD

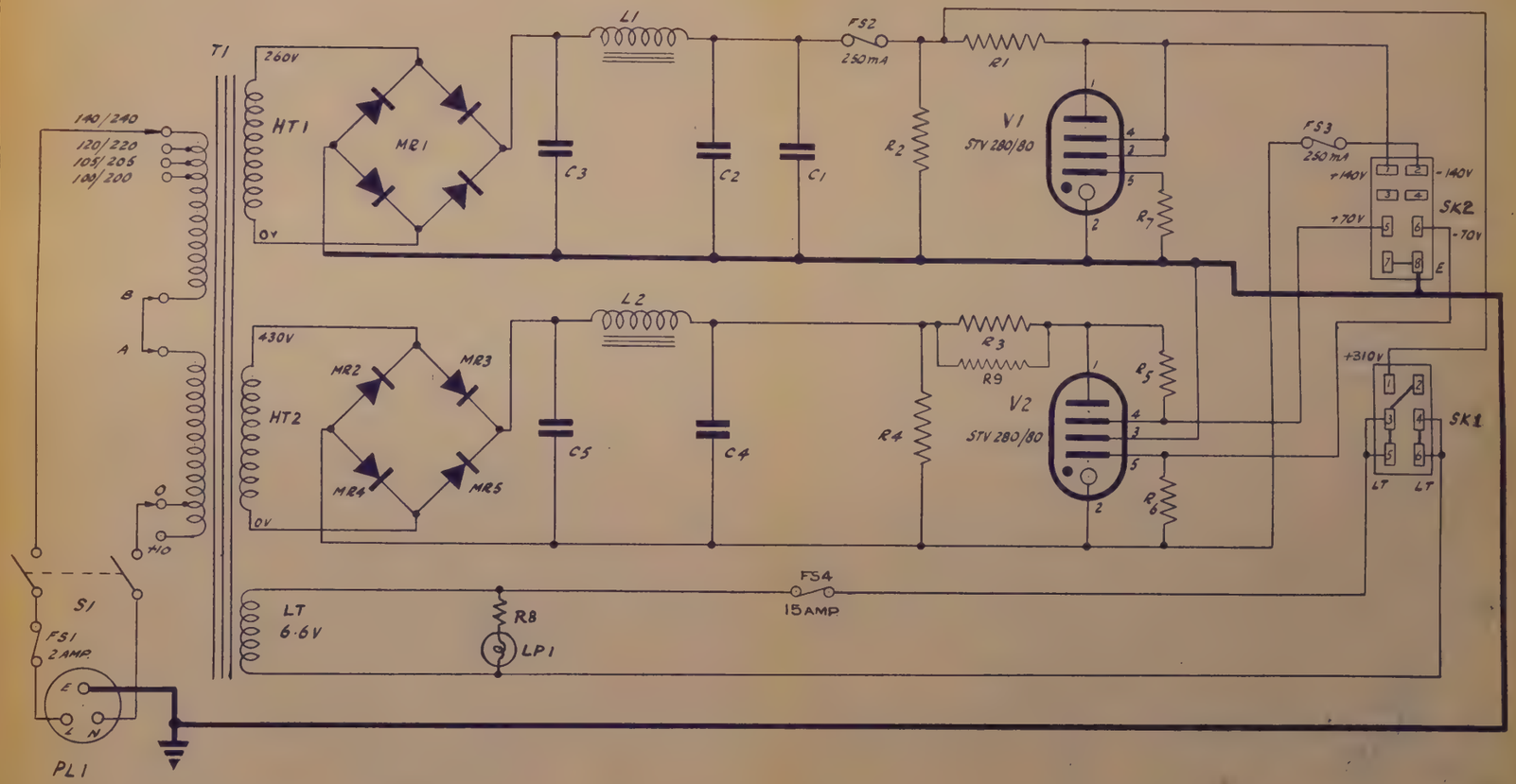
CIRCUIT DIAGRAM

OF

STABILIZED POWER UNIT

TYPE TM5195

(PART OF TF1167)



CIRCUIT DIAGRAM OF STABILIZED POWER UNIT TYPE TM5195 (PART OF TF1167)

MARCONI INSTRUMENTS LIMITED							
DRN	M.C.	DATE	28·1·58	CHKD		ISSUE	6
STOCK LIST	TF 1167			DRG No	TLC 27802		

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	·006310	**22**	12·59	158·5
·06310	·003981	**24**	15·85	251·2
·05012	·002512	**26**	19·95	398·1
·03981	·001585	**28**	25·12	631·0
·03162	·001000	**30**	31·62	1,000
·02512	·0006310	**32**	39·81	1,585
·01995	·0003981	**34**	50·12	2,512
·01585	·0002512	**36**	63·10	3,981
·01259	·0001585	**38**	79·43	6,310
·01000	·0001000	**40**	100·00	10,000
·007943	·00006310	**42**	125·9	15,850
·006310	·00003981	**44**	158·5	25,120
·005012	·00002512	**46**	199·5	39,810
·003981	·00001585	**48**	251·2	63,100
·003162	·00001000	**50**	316·2	100,000
·002512	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	158,500
·001995	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	251,200
·001585	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	398,100
·001259	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	631,000
·001000	10^{-6}	**60**	1,000	10^{6}
·0005623	$3{\cdot}162 \times 10^{-7}$	**65**	1,778	$3{\cdot}162 \times 10^{6}$
·0003162	10^{-7}	**70**	3,162	10^{7}
·0001778	$3{\cdot}162 \times 10^{-8}$	**75**	5,623	$3{\cdot}162 \times 10^{7}$
·0001000	10^{-8}	**80**	10,000	10^{8}
·00005623	$3{\cdot}162 \times 10^{-9}$	**85**	17,780	$3{\cdot}162 \times 10^{8}$
·00003162	10^{-9}	**90**	31,620	10^{9}
·00001000	10^{-10}	**100**	100,000	10^{10}
$3{\cdot}162 \times 10^{-6}$	10^{-11}	**110**	316,200	10^{11}
10^{-6}	10^{-12}	**120**	10^{6}	10^{12}
$3{\cdot}162 \times 10^{-7}$	10^{-13}	**130**	$3{\cdot}162 \times 10^{6}$	10^{13}
10^{-7}	10^{-14}	**140**	10^{7}	10^{14}

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	0	1·0	1·0
·9886	·9772	·1	1·012	1·023
·9772	·9550	·2	1·023	1·047
·9661	·9333	·3	1·035	1·072
·9550	·9120	·4	1·047	1·096
·9441	·8913	·5	1·059	1·122
·9333	·8710	·6	1·072	1·148
·9226	·8511	·7	1·084	1·175
·9120	·8318	·8	1·096	1·202
·9016	·8128	·9	1·109	1·230
·8913	·7943	1·0	1·122	1·259
·8710	·7586	1·2	1·148	1·318
·8511	·7244	1·4	1·175	1·380
·8318	·6918	1·6	1·202	1·445
·8128	·6607	1·8	1·230	1·514
·7943	·6310	2·0	1·259	1·585
·7762	·6026	2·2	1·288	1·660
·7586	·5754	2·4	1·318	1·738
·7413	·5495	2·6	1·349	1·820
·7244	·5248	2·8	1·380	1·905
·7079	·5012	3·0	1·413	1·995
·6683	·4467	3·5	1·496	2·239
·6310	·3981	4·0	1·585	2·512
·5957	·3548	4·5	1·679	2·818
·5623	·3162	5·0	1·778	3·162
·5309	·2818	5·5	1·884	3·548
·5012	·2512	6	1·995	3·981
·4467	·1995	7	2·239	5·012
·3981	·1585	8	2·512	6·310
·3548	·1259	9	2·818	7·943
·3162	·1000	10	3·162	10·000
·2818	·07943	11	3·548	12·59
·2512	·06310	12	3·981	15·85
·2239	·05012	13	4·467	19·95
·1995	·03981	14	5·012	25·12
·1778	·03162	15	5·623	31·62

MP MASTER
MA23625